Sudhi Seshadri

Sourcing Strategy

Principles, Policy and Designs

Springer



Sourcing Strategy

Sourcing Strategy
Principles, Policy and Designs

By
Sudhi Seshadri, Ph.D.

Springer

Library of Congress Cataloging-in-Publication Data

A C.I.P. Catalogue record for this book is available
from the Library of Congress.

ISBN 0-387-25182-0 e-ISBN 0-387-25183-9 Printed on acid-free paper.

© 2005 Springer Science+Business Media, Inc.
All rights reserved. This work may not be translated or copied in whole or in part without the written permission of the publisher (Springer Science+Business Media, Inc., 233 Spring Street, New York, NY 10013, USA), except for brief excerpts in connection with reviews or scholarly analysis. Use in connection with any form of information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now know or hereafter developed is forbidden.
The use in this publication of trade names, trademarks, service marks and similar terms, even if the are not identified as such, is not to be taken as an expression of opinion as to whether or not they are subject to proprietary rights.

Printed in the United States of America.

9 8 7 6 5 4 3 2 1 SPIN 11363897

springeronline.com

To Shreelata,

for being there at the beginning of this project, and all her support in taking it to its completion.

Contents

List of Exhibits	*ix*
Preface	*xi*
Acknowledgements	*xix*
PART 1: Principles and Policy	***1***
1: Sourcing Strategy	*5*
2: Outsourcing	*13*
3: Architecture and Processes	*31*
4: Sourcing Goals and Objectives	*51*
5: The Government Sourcing Environment	*65*
6: Costs and Performance Risks	*77*
7: Contracts and Incentives	*93*
8: Source Selection	*111*
9: Supplier Strategies	*139*
10: Sourcing Reports and Data	*155*
PART 2: Design	***169***
11: Foundations of Sourcing Analysis	*177*
12: Sourcing Design Elements	*187*
13: Risks and Rewards of Multiple Sourcing	*193*
14: Capacity Constraints and Pricing in Sourcing Markets	*211*
15: Syndicates, Risk and Demand Uncertainty	*229*
16: Risks and Resource Sharing	*243*
17: Selection and Incentives for Innovation: LIC	*255*
18: Selection and Incentives for Innovation: Yardstick Contracts	*269*
Notes	***287***
References	***297***
Subject Index	***315***

List of Exhibits

Exhibit 1.1: Systems contrasted with Strategy. 8
Exhibit 1.2: Nissan Motor Company Analysis of Global Financial Performance. 9
Exhibit 1.3: Re-engineered Levels of Function, Architecture and Process in Sourcing Strategy. 11
Exhibit 2.1: Percent outsourced merchandise and manufactured goods (COGS) of total Revenue. 20
Exhibit 3.1: Strategic sourcing governance architecture. 33
Exhibit 3.2: Dynamics of Markets, Contracts and Relationships. 40
Exhibit 3.3: Proxsys® Academic Version: Contents. 46
Exhibit 3.4: Environment Indexes 47
Exhibit 3.5: Fixed Price Contracts Module. 48
Exhibit 4.1: Tradeoffs in component economic quantities in acquisition. 60
Exhibit 5.1: Sourcing awards and capacity utilization. 69
Exhibit 5.2: Pre-and Post-Award price. 71
Exhibit 6.1: Types of accounting costs. 86
Exhibit 6.2: Cost Drivers. 88
Exhibit 7.1: Disclaimer Sources of Risk. 96
Exhibit 7.2: A comparison of common contract designs. 103
Exhibit 7.3: A comparison of competitive markets and relationship contracts for dimensions of tradeoffs. 106
Exhibit 7.4: The IT Services Contract map. 110
Exhibit 8.1: The buyer's technical bid evaluation index. 115
Exhibit 8.2: Marginal expense and optimal reverse auctions. 134
Exhibit Part 2: Summary features of standard sourcing designs. 173
Exhibit 11.1: Ordering of Bids and Bidding Strategy. 183
Exhibit 11.2: The Relative Perceived Price-Quality Chart. 184
Exhibit 11.3: Example for Price-Quality chart. 185
Exhibit 13.1: The sourcing decision process. 196
Exhibit 13.2: Entry diagnostics in multiple sourcing. 199

Exhibit 13.3: Exercise 1.1 on Fixed Price Contracts. 208
Exhibit 13.4: Further Questions on Fixed Price Contracts. 209
Exhibit 14.1: Reserve price –capacity curves and award types. 215
Exhibit 14.2: Exercise 2.1 on Capacity Constrained Contracts. 226
Exhibit 14.3: Fixed Price Award on Capacity Constrained Contracts. 227
Exhibit 14.4: Buyer Demand Uncertainty on Capacity Constrained Contracts. 228
Exhibit 15.1: Discriminatory second price (totem pole) award. 237
Exhibit 15.2: Exercise 3.1 on Syndicated Source Contracts. 240
Exhibit 15.3: Syndicate source contracts 241
Exhibit 16.1: Exercise 4.1 on Equity Sharing Contracts. 253
Exhibit 17.1: Risk averse vendor's insurance rents. 262
Exhibit 17.2: Components of buyer's cost. 266
Exhibit 17.3: Incentive Fee Contracts: Linear Incentives. 268
Exhibit 18.1: Exercise 5.1 on Incentive Fee Contracts. 282
Exhibit 18.2: Incentive Fee Contracts: Comparison. 283
Exhibit 18.3: Incentive Fee Contracts: Winner's Purse. 284
Exhibit 18.4: Incentive Fee Contracts: Share of Business. 285

Preface

Sourcing managers enjoy the Confucian blessing as they "live in interesting times." Functional sourcing has changed dramatically in recent years with the convergence of communications and computing, and the advent of electronic exchanges, global markets and the internet. There are seemingly infinite possibilities in sourcing process design. Such a range of choices in functional aspects of sourcing is bound to raise goal conflicts and supply chain conflicts. The sourcing chief executive, as the newest member of the boardroom, must chart strategic implications for the firm of rapidly evolving sourcing environments.

But emphasis on sourcing is no fad. Some years ago the university where I taught conducted a foundation stone laying ceremony for its new business school building. In order to mark the day, faculty and MBA students were to provide advice to management students for inclusion in a time capsule. The capsule would be opened in fifty years, and the only restriction was to submit advice that would continue to be relevant for business management that far into the future. I happened to mention this challenge in a conversation with a senior colleague in another business school. His spontaneous response was: "The one dictum that would still be valid a half-a-century from now? Buy low, sell high!" Sourcing strategy is primarily about the first part of this mantra.

Purpose and intended audience

Sourcing Strategy: Principles, Policy and Design is written for the student of sourcing, whether he or she is a business studies major, a public administrator, an executive in private enterprise, or an aspiring manager. *Sourcing Strategy* is aimed at satisfying the need for an accessible management book on strategic sourcing policy and designs, based on sound theoretical principles. It assumes no more than awareness from the reader that he or she must understand supply chain and supply base design issues to justify choices, for short and long-term profitability or efficiency of his or her administrative or business unit.

A naïve manager may be tempted to approach sourcing as a routine purchasing activity. But sourcing is increasingly recognized as a strategic area in management studies. You may encounter it in several avatars, such as strategic purchasing or industrial buying, or as special topics in business-to-business (B2B) marketing. This book serves as an introductory textbook, stressing principles of sourcing for policy issues and designs. It is primarily aimed at the motivated student at senior levels in an undergraduate economics-and-business curriculum, or at master's level students in an elective MBA course.

In what follows it will become clear that the book aims to fill a gap in the serious student's library between descriptive and analytical problem-solving approaches to sourcing. It does this without either sacrificing accessibility or demanding mathematical ability, while providing a modern, interdisciplinary and holistic view of sourcing strategy. With this goal it also seeks to be of value to the progressive executive or administrator responsible for sourcing. After reading this book I hope that the reader will be productively engaged in applying principles, policies and designs to their own sourcing strategy.

Insights from quantitative models

The goal of the book is not merely to document sourcing strategy, but to provide tools to determine it. Therefore, rather than merely describe common sourcing processes the book takes a normative approach to sourcing strategy. It argues for a rational, complete and integrated process view. It supports its recommendations with logical arguments from an interdisciplinary and analytical approach grounded in microeconomics, law and business strategy. Many leading scholars in these disciplines have developed pieces of the pattern. Scholarly quantitative research in business-to-business marketing, bidding, auctions, contracting and operations management has addressed complex issues of intermediate markets.

Is such scholarly research necessarily inaccessible to the general reader? Professor Rogerson (1994; in his review of Professors Laffont and Tirole's book) stresses differences between theorists and non theorists in sourcing, and calls for user friendly approaches. Professor Rogerson defined audiences most colorfully. Non-theorists are people involved with applied models and practitioners. One group among them, skeptics, reject the claim that real phenomenon and actual applications are captured in formal models; while another group, the dazed and confused, find the whole program of formal modeling of imperfect markets incomprehensible, and don't even follow insights and intuition.

This need not be so, as new concepts from scholarly work in economics and business *can* be made accessible. Exemplary illustrations are provided by

Professor McMillan's books, *Games, Strategies, and Managers* (1992); and *Reinventing the Bazaar* (2002). The ideas in these books are conceptually rich and wide ranging. In some sections they deal with auctions and their applications, and in others deal with a variety of incentives in business. They dispense with mathematical exposition, in favor of intuition and lively examples. The reader is therefore presented with, among other areas, a wide-ranging introduction to auctions and incentives in real world settings of private and public enterprise. *Strategic Sourcing* too endeavors to build a bridge from the general reader to the specialized scholar for sourcing strategy.

Perhaps a book for the general reader could lose insightfulness and precision of underlying scholarly articles. One reviewer, Nyarko (1993) feared that "verbal and descriptive accounts of theory would reduce such books to platitudes and proverbial statements." However, he found that in the particular case of Professor McMillan's book his apprehension was unfounded. While also aimed at the general reader, *Sourcing Strategy* is very aware of this danger, and the very high standards of exposition necessary to avoid this pitfall. The subject matter in *Sourcing Strategy* is accordingly modest and circumscribed – focused entirely on interplay of risk-reward tradeoffs in the sourcing process, and resulting implications for supply base design. It could also therefore afford to be more comprehensive on this issue.

All managers are in a trapeze act every day, between qualitative decision and computational rationale. The body of knowledge in auctions and bidding theory has a unique and curious theorem on the importance of computation. The Revelation Principle in optimal auction design (discussed later in Chapter 8) is based on the argument that the bid taker is in the position to compute optimal sellers' bids better than anyone else.

While emphasizing principles and policy insights the book has an orientation that values computation, with *sourcing "engineering"* as a guiding principle. The book avoids need for mathematical exposition, and presents its insights *without use of equations.* However, there is liberal use of tables, charts and graphs. Computation based on underlying equations and formulas is dealt with in a companion software implementation (included with this book). The book thus provides the option of sophisticated computational approaches, and not just back-of-the-envelope calculations. Exposure to these computations allows us to compare relative magnitudes of a variety of costs, and to assess strategic risk-reward tradeoffs that ensue for different sourcing designs.

The models are based on theory, and the mathematics has for the most part already been validated since the bulk of applications are based on journal publications. This approach is specially tailored for those who want insights, applications, and sophisticated numerical examples, but can't afford mathematical theory. It hopes to take formal models out of the classroom and

faculty office to the desk of the practitioner, and provide practical guidance to those who must deliver quantitatively measured policy in sourcing scenarios. This development of the "Swiss army knife" of contract designs is inevitable and *Sourcing Strategy* believes that its time is overdue.

A focus on strategy rather than systems

Strategic sourcing requires balancing of several sourcing objectives. These objectives may sometimes be in conflict, and tradeoffs would be necessary. Conflicts between businesses abound within supply base and supply chain as well. A fundamental strategic concern is governance of conflicts. But this concern is not central to the systems approach.

Textbooks on purchasing management have emphasized the systems viewpoint. They describe best practices in purchasing activity and techniques. The set of benchmark process recommendations are usually heuristics that codify experience. Systems for purchasing management with the prime objective of materials management would be somewhat different from systems tailored for supply chain management. Functional differences arise for different industries and systems we learn about from these textbooks can and should be modified for best performance under differing environments.

However, the systems viewpoint assumes away conflicts of interest. Multiple goals lead to conflicts within all systems. At the fundamental level there is a conflict of resource allocation choices. What is optimal for one goal is suboptimal for another. Hard choices are necessary to optimize activity towards achieving multiple goals. Scenarios where other goal conflicts exist are not hard to visualize. Vertical and horizontal conflicts are common in sourcing. For instance, vertical conflicts exist due to opposing interests between buyers and sellers. Horizontal conflicts are due to competition within the supply base. *These conflicts are reasons why systems may not just under perform but actually collapse with catastrophic results.*

Other problems arise with a purely systems view of sourcing. Long term and short terms goals may also be in conflict. Sourcing may be for programs that span ten or more years, from their genesis to liquidation. The attendant shorter projects or contracts within these programs may last just a few months. Capacity development is usually a long term goal whereas production cost minimization is a conflicting goal in the short term. The parties to exchange must make tradeoffs to manage these conflicts.

Uncertainty and information asymmetry among parties leads to further complications. For instance, the parties may have conflicting views on performance as not all inputs to the sourcing system can be verified. The risk

attitudes of parties to the sourcing exchange add complexities to conflicts of interest.

A supply base is not a corporation, and it is a mistake to think sourcing strategy is a monolithic corporate strategy. The divergent interests of suppliers as agents and buyers as principals lead to the need to align interests through appropriate sourcing mechanisms. Interactive decision processes, with interdependent outcomes, that characterize sourcing processes are the domain of game theoretic analyses. The particular information structures that characterize procurements and the uncertainties and information asymmetries in modern development and production relationships lead to sourcing games of incomplete information. In the last two decades business and economics research programs have addressed limitations inherent in the systems view. These research programs have consciously placed conflict as central in the process of business and sought to design and implement conflict resolution mechanisms. A new strategic view of business processes has therefore emerged to complement the systems view.

Distinguishing features of the book

A fundamental distinguishing feature in the approach in this book is its focus on interplay between selection and incentive risks. This has to do with interaction of supplier selection reverse auctions with contract performance in the sourcing processes. The modern view of sourcing recognizes that suppliers always have the option of exchange on the spot market, and it is a participation decision to commit some of their capacity to contractual procurements. *Sourcing Strategy* is concerned with a basic tenet: integrate risks and rewards of supplier incentives with supplier selection. Sourcing which does not account for both selection and performance is myopic and certainly will not account for evolving governance modes. Myopic prescriptions are the bane of strategy.

A supply base with a sole or single supplier is a convenient fiction more than dominant sourcing practice. A second fundamental distinguishing feature in the book's approach is its focus on parallel sourcing or multi-sourcing. Principals usually engage services of multiple agents in most business relationships. Agents interact among themselves, and strategic behavior emerges that is not usually observed with single agents. The isolated agent is more a rarity than the rule. Splitting the award among multiple suppliers in the presence of risk is a major reason why multiple sourcing is a powerful supply base design approach, and is a major interest here. In all other books we are aware of and could cite here, the focus is on winner-take-all auctions. Our preference is for an unrestricted "multi-agent-auction-contract."

Some other distinguishing features of the book are noteworthy of mention here. The book takes a view of sourcing as a programmatic activity, evolving over time. Different phases require different sourcing strategies to deal with risk and return tradeoffs. The book distinguishes several phases that programs could pass through, and increases the reader's awareness of changes in decision approaches necessary for evolution. This approach highlights advantages of multiple sourcing over the lifetime of the sourcing program, as it introduces competitive considerations in evolving contexts.

The approach carefully analyses diverse origins and impact of a variety of costs. The issues relevant to costs change as the sourcing program evolves, with uncertainties and associated risk differences. The usual approach to auctions is to model private values or common values exclusive of each other. While affiliated values approaches are likely, models here focus exclusively on independent private value approaches. Some analyses in the book include common production costs in particular bidding situations as opposed to private costs. In addition, the book includes analyses of several other costs including opportunity costs, joint costs, investments, innovations, and effort costs.

Suppliers are not usually as dedicated as they are made out to be. Multi-market business opportunities are possible, and substantial capacity is sold on spot markets. The supplier has the option to depart from sourcing business and employ capacity in spot markets. Our approach formally recognizes these scenarios. The interaction of spot markets with sourcing business is an underlying theme.

There are many award types to choose from, and each possesses distinct benefits or costs. A feature of the book is its discussion of a variety of pricing and contracting approaches. Apart from uniform or discriminatory pricing awards, we examine first and second price approaches. The book analyses various combinations of price discovery elements. We discuss, in addition to popular and widely used models, lesser known auction varieties such as the discriminatory second price multiple source model and the second quantity auction that have particular advantages in some situations we consider.

Principles, Policy and Design

A few words on what this book is *not about*. This book will not dwell on the variety of ways e-sourcing systems will improve supply chain collaboration, or reduce the order cycle time; nor will it detail how specific companies implemented their latest supplier management system although that is a hugely important area of sourcing reform. It is not about clerical procedures in sourcing, nor about technologies in supply chains.

The book is organized in two parts.

PART 1: Principles and Policy is meant as an introduction to the main concepts, and draws upon results of much recent research in related domains. It presents a survey of the more important concepts and theoretical results as well as empirical findings for sourcing strategies. It is cross-disciplinary and integrative. The ten chapters in this part provide motivation and intuition behind design scenarios and applications presented in the sequel.
PART 2: Designs deals with standard scenarios in sourcing. It highlights specific strategic queries and answers them with designs and decisions. Most of the eight chapters in this part are largely based on validated models. We abstract away from mathematics in original models to present intuition in verbal and descriptive form. The implementation of math in an academically useful software package allows essential insights into designs.

Taken together the two parts aim to introduce a coherent approach to further the science and art of sourcing. The *science of strategic sourcing* is in principles and designs of mechanisms for conflict governance; and the *art of strategic sourcing* is in the manager's ability to bring necessary policy to bear when governance mechanisms must support sourcing relationships over the longer term.

Acknowledgements

I am grateful for the direct and indirect support I have received from so many colleagues. While my debt can never be fully acknowledged I will attempt to name a few who have been exceptionally generous over the years.

As a junior faculty at the University of Maryland at College Park I was fortunate to meet Martin Loeb, who was working in related areas. I benefited from rigorous standards he brought to dissertation committees. The excellent Marketing and Management Science faculty colleagues I was privileged to know at UMCP certainly encouraged my research orientation.

More recently, academic Directors at Indian Institute of Management Bangalore, Rammohan Rao and later Prakash Apte, actively encouraged my research and provided valuable opportunities for interaction with the region's B2B and IT industry. Many colleagues and students at IIMB helped sharpen my research ideas, among whom I would particularly like to mention Jishnu Hazra and Randhir Mishra.

At Singapore Management University, support of Dean David Montgomery and Marketing Area Chair Jin Kyun Han has been invaluable. This book would not have been possible without opportunities afforded for quality work at SMU.

Many able persons at Kentropy Technologies helped make software implementation that accompanies this book possible. Their patient attention to detail was only surpassed by their cheerful attitude to dozens of iterations we went through *en route* to our current version of Proxsys. I am particularly grateful to Rajeev K. and Joyjit Dutta for their inputs.

Finally, my thanks to Sean Lorre of Springer Books and Media for his timely inputs and editorial help.

PART 1
Principles and Policy

Introduction to PART 1

Part 1 of this book addresses principles that underlie sourcing and their policy implications for strategic sourcing. It distinguishes short-run and long-run approaches to supply base development. Part 1 seeks to integrate these principles and policies with robust sourcing architectures. The following chapter-wise outline provides an overview.

1: Sourcing Strategy: The firm engages in processes ranging from functional to strategic, and the perspective at each level can be very different. The chapter serves to provide the context for study of sourcing processes. It emphasizes the strategic nature and role of sourcing in the modern firm or contemporary public agency. It highlights the importance of balance in risks and rewards between buyer and suppliers, and how management of sourcing permeates all levels of executive responsibility in the modern organization.

2: Outsourcing: Like the pre-existing supply base presumption, a pre-existing market demand for intermediate goods cannot be taken for granted. The basic "make or buy" decision drives the degree of outsourcing in the company. Starting from this decision, the chapter examines how types of goods and services influence outsourcing, and reports on research into scope and extent of outsourcing world over. There is a fundamental distinction between outsourcing at the economy level and at the company level. The chapter reviews processes and technologies that have fueled this rapid growth in outsourcing. The chapter concludes with the central importance and logic of the multi-sourcing perspective.

3: Architecture and Processes: Departing from a merely descriptive approach, we develop a constructive approach to sourcing strategy. The chapter develops the conceptual architecture for strategic sourcing in institutional buying and B2B buying. While it provides a classification of processes relevant to a systemic multi-sourcing principal-agent approach, the chapter develops the strategic programmatic view of purchasing emerging in recent times. It distinguishes between short run sourcing governance mechanisms and long run sourcing strategies, and develops inter-relationships between markets, contracts and relationships. The chapter ends with an introduction to *Proxsys*®, the sourcing expert system that accompanies this book. The software exercises illustrate concepts and applications in this book with computational approaches.

4: Sourcing Objectives: There is little value in implementing a strategy with confused and conflicting goals. The chapter identifies main objectives and goals

that a sourcing strategy must address. Five key areas of concern are performance gains, capacity management, governance flexibility, acquisition cost and renting competencies. The primary concerns of buyers and sellers in sourcing relationships arise from these objectives and goals. The various objectives interact with each other and lead to evolving risk-reward tradeoffs for buyers and sellers. The challenges for sourcing strategy in the long run and for sourcing governance mechanisms in the short run emerge from recognition of these objectives and goals.

5: The Government Sourcing Environment: A high priority in government sourcing is renting competencies of suppliers. The confluence and conflicts this engenders with other objectives determines sourcing strategy. The importance of acquisition reform in public goods supply cannot be understated. Most countries have elaborate structures for government spending. The chapter surveys objectives and scope of government sourcing, and approaches and pitfalls of pricing government contracts. We draw insights from valuable empirical findings on sourcing programs.

6: Costs and Performance risks: The spot market on the one hand and termination-prone relationships on the other are unsatisfactory governance modes. The chapter outlines the role of the sourcing contract as a governance mechanism with attendant obligations and risks. The chief concern is performance and how contracts may evaluate and deal with performance risks. It classifies and details costs in contracting, and identifies a variety of sources of risk and costs. The chapter concludes with identification of major cost drivers in sourcing.

7: Contracts and incentives: The luxury of full information in contracting is a fiction. Contracts must provide appropriate incentives, and this chapter elaborates on the ability of sourcing contracts to employ incentive risks. A major role of incentives is for cost control effort, much of which is unobservable. The compensation to suppliers deals with observable and auditable costs, as well as unverifiable and unobservable costs. The chapter describes various approaches to incentive risk-reward tradeoff. It describes how contracts deal with price and how the financial burden of risk is allocated between parties in situations of uncertainty. The chapter also introduces and discusses standard contract forms, such as the Linear Incentive Contract (LIC), and yardstick contracts.

8: Source selection: Internal cost estimation by the buyer is a good starting point for price discovery, but arriving at the best result depends on a mix of criteria. The chapter develops a detailed understanding of source selection processes. It outlines selection risks vendors face and the consequent impact on competitive behavior. It clarifies the relationship to negotiation, and discusses the superiority of bidding. It introduces a taxonomy of auctions and bidding award types and discusses similarities and differences. It presents and explains the main results in auction theory that have far reaching implications for source selection. It discusses further variations of reverse auction award types that we frequently encounter in sourcing strategy. The chapter concludes with major insights into

why auctions are optimal source selection processes and how the optimal auction is designed.

9: Supplier Strategies: The supply base is comprised of strategic agents with alternatives, and the buyer should not take vendor alignment of objectives for granted. This chapter is aimed at developing a comprehensive understanding of supplier behavior in response to source selection awards. The chapter identifies vendor approaches to forming bidding strategies, and their dependence on a variety of considerations. It describes stages of the sourcing process where vendors make key decisions and how award types influence vendor entry decisions into sourcing business. The discussion elaborates on the role of opportunity costs, and the importance of competitors in the supply base. The chapter concludes with a discussion of pre-and post-award considerations due to incumbency.

10: Sourcing Reports and Data: Strategic sourcing is a distributed but planned activity in the firm and must not be construed as a one time effort. This chapter outlines considerations in implementation of the sourcing architecture. It identifies specific reports and other entities in the workflow. The chapter discusses the sequence of activities, uses and actors in the process. We distinguish implementation in three levels of clerical, functional and strategic sourcing activity. The chapter outlines modern tools and techniques for data capture and processing for decision support in sourcing, such as data mining and business intelligence. The chapter ends with dimensions of implementation in the modern corporation such as compatibility with enterprise-wide systems, and human resource issues.

1: Sourcing Strategy

1.0 Introduction

Among the many business processes in the modern firm or adopted by the contemporary public agency, the sourcing process is probably the most affected by changes brought about by the new economy. These developments often make prescriptions for supplier management from outdated processes seem naïve. The following sections describe the domain of sourcing issues, and changes in the buying process. Some questions it addresses are: How does the modern executive view sourcing? What are risks and rewards of a well executed sourcing strategy? Where is sourcing strategy headed? The chapter highlights differences between functional and strategic aspects of sourcing.

1.1 The new sourcing paradigm

Technological developments, global communications and cross-border marketing are changing business paradigms. Outsourcing relationships between firms now include many traditionally internal processes. The variety of business entities is growing. The modern manager or administrator, whether in a government agency or the consumer market space or in business marketing, must surmount many tiers of business relations simultaneously. Managers, concerned with better business administration, must face entirely novel possibilities for establishing and building business relationships across the value chain in business-to-business (B2B) markets. How are we, as practitioners, consultants, students, researchers, and teachers of management science, to grasp the many levels of risks and rewards in this new environment? How to choose appropriately among complex choices involving implicit and explicit business partnering and contracts? What are competitive risks and incentive risks behind foreseen or unforeseen returns? The many and confusing layers of strategic relationships reflect myriad possibilities in modern business markets.

The activity of sourcing is today undergoing a renaissance. Business management texts are being rewritten, to include advances in concepts and approaches to B2B sourcing relationships (for example, Hutt and Speh 2003). The process of information and goods/services flow through stages of processing from raw materials to finished products are being integrated into thinking on sourcing.

Thus, activities that affect buyer-seller relationships, that is, business-to-business interactive aspects of supply chain activities have come into the purview of sourcing (Ford 1980; Dwyer, Schurr and Oh 1987). These include both back-end concerns, such as source selection and control of vendors, sourcing mechanisms and designs, under the banner of supplier relations management (SRM); and front-end concerns, such as distribution, customer service and customer relationship management (CRM). Modern business processes seek to integrate these concerns of sourcing into other traditional within-firm functions such as order processing, inventory management, production scheduling, operations or enterprise resource planning (ERP) systems, and with newer functions such as business intelligence (BI).

With all the dynamism in sourcing processes it is reasonable to expect a sea change in the way business administration views sourcing. An essential instrument in the chief executive's strategic plan now is sourcing. The public agency concerned with government buying is often at the forefront of these changes. Knowing how to buy is indispensable for all buyers, whether institutional or business.

1.2 Institutional buying and B2B buying

Organizational buying has traditionally been an important area in business processes and business education. Industrial marketers are especially concerned with the strategic nature of decisions in buying and selling products and services when there are few firms in the marketplace. Governments all over the world procure goods and services in the public interest from private industry or autonomous public sector undertakings. Some estimates put the annual volume of goods and services procured worldwide at $14 trillion, or approximately sixty percent of the world's gross domestic product. Estimates of government sourcing alone are at 10 percent of national income. Clearly, added efficiencies in institutional buying would contribute immensely to national exchequers.

The shift in B2B from "discrete purchase" to "integrated, cross-functional sourcing" is a radical shift. New processes introduce organizational changes. In the old paradigm each business in the multi-SBU firm would requisition purchasing or administration for its needs. The silo mentality was widespread in purchase departments. The move from this mentality to centralized profit center thinking for sourcing meant that businesses across the company would need to develop new company-wide policies. Many firms not only centralized procurement functions, but also started global sourcing offices. Policies and processes are becoming institutionalized through cutting edge information technology systems and platforms. The rationale for such strategic shifts from simpler B2B purchasing arrangements to institutional sourcing systems is simple and alluring. Even a small saving in the costs of goods outsourced could translate

to a large increase in profitability rates in many mature industries facing competitive pressures.

The ripples across the organization change routine activity, affecting all levels of executive action. Change in established behavior on this scale requires strong justification, and organizational change requires backing of senior management. There is no doubt that top company leadership is quick to appreciate the value proposition for strategic sourcing.

1.3 Functional and Strategic Sourcing

What is needed to transform traditional purchasing management to a strategic sourcing process? The purchasing management approach is primarily based in principles from systems theory. The elements of a system are inputs, process and outputs and the objective is to design a system that best performs a given function. Sourcing strategy builds upon the purchasing management approach as it recognizes need for conflict management in purchasing, and adds principles from decision theory and game theory (Chatterjee and Lilien 1986). It identifies conflicts of interest in the sourcing process and emphasizes dilemmas. Exhibit 1.1 summarizes the many shifts in emphasis necessary for a strategic rather than a purely systems viewpoint.

Among sourcing decisions that are typically considered strategic are entry into and exit from product-markets, capacity development and management in the supply base, selection and maintenance of sources of supply, innovation and quality issues, cost controls over the long-term, and the price discovery process. Buyers engage in strategic sourcing that seeks to influence behavior of sellers and develop supply bases.

Senior management seeks competitive advantages from sourcing efficiencies. Successful programs have improved sourcing costs from 10 to 50 percent. We can appreciate the true significance of this when we recognize that a 10 percent reduction in purchase costs can lead to as much as 50 percent increase in profit margins.[1]

In the past 50 years the cost of production related goods and services have tripled to an average of almost 56 percent of sales – so an issue of governance in these costs arises. How to get 30 % or more cost reductions? Skilful negotiation will yield 1-2 % at most. World-class manufacturing reduces costs to 10-20%; however, world class sourcing offers the potential of cost reductions to 60-70 %. The strategic tasks are by no means easy although they may be easy to state: to select sources and to develop relationships to manage suppliers and the supply base.

Systems	Strategy
Scope: Process and sequence of techniques useful for implementation	Scope: Process sequence of decision and choices useful for conflict resolution
Goals are singular, non controversial, functional and systematic	Multiple goals possibly in conflict, leading to dilemmas
Used in workflows for business process	Used in governance of business process
Minimal differentiation between short & long term	Substantial differences between short and long term
Codifies experience for justification of practice	Codifies rational and causal linkages for justification of recommendations
Output is used for feedback to modify how input is processed	Feedback is interactively optimizing subsystems
Changes in exogenous input can be handled by adaptive dynamic and flexible systems	Adaptive and dynamic based on endogenous outcomes
Harmonized, centrally planned, blueprints with no conflicts of interest	Decentralized conflict resolution mechanisms
Stable hierarchical exogenous choice criterion with administrative subsystems	Evolutionary with scenario driven endogenous comparisons for choice criterion
Descriptive narrative and factual with input, process and output formulation	Normative and explanatory with extensive & reduced form game formulations
Optimal first-best and benchmarked solutions in absence of competition	Equilibrium tradeoffs, not first-best due to agency costs and coordination losses
Optimal choices leading to deterministic outcomes for any given realization of random variables	Incentive compatible and individually rational choices leading to probabilistic outcomes with uncertainty on utilities
Formal models with empirical or statistical probability distributions capturing uncertainty of mechanistic players	Formal models with subjective probability distributions and Bayesian decision makers, possibly with risk aversion
Applications in order processing, invoicing, inventory management, logistics	Supplier selection , innovation and design contracts, financial structure, capacity and investments, acquisition cost management

Exhibit 1.1: Systems contrasted with Strategy. The exhibit highlights the difference in perspective between systemic and strategic views of sourcing.

A recent example of a strategic campaign in sourcing that has yielded hugely significant payoff is Nissan Motor Company's revival plan. The incremental impact on operating profits of sourcing reform, relative to other sources of operating profit, is evident from Exhibit 1.2. The gain due to sourcing strategies alone is over 25 percent of operating profit in the first half of 2003. The

realization that these gains repeat to perpetuity multiplies the gain for overwhelming benefit.

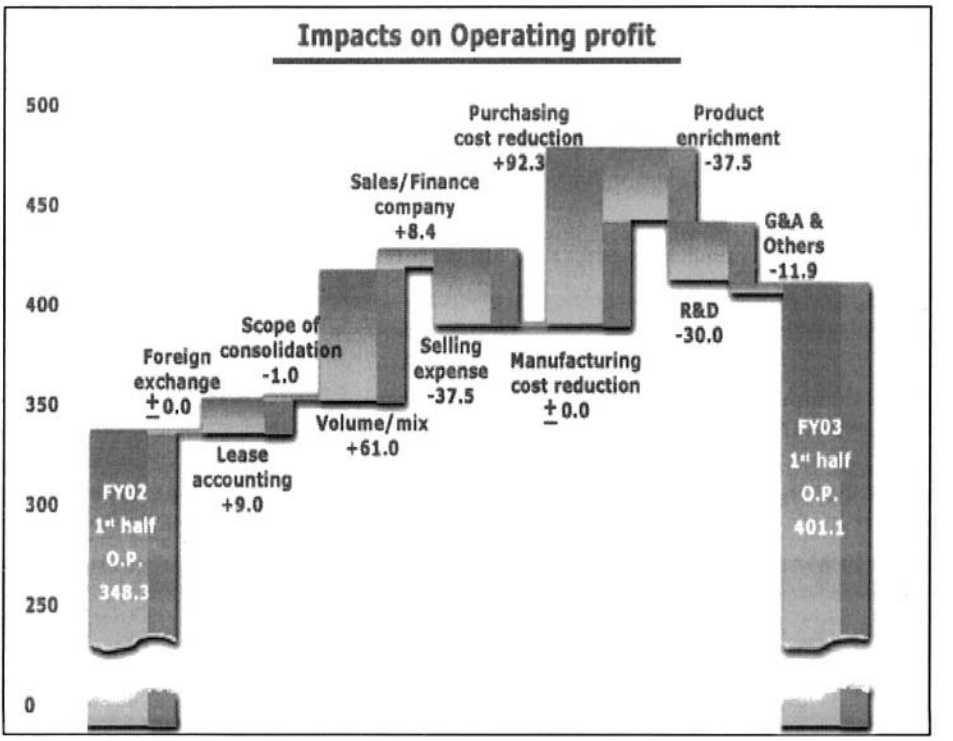


Exhibit 1.2: Nissan Motor Company Analysis of Global Financial Performance. The report draws attention to the impact of purchasing cost reductions (among other impacts) on improvement in operating performance. The chart breaks down contributions to operating profit (OP) in the first half of the corresponding years, in billions of yen. The impact of purchasing cost reductions is over 26 percent for the year 2003, an outcome of a major company campaign on strategic procurement and supply base design. *Source: Adapted from Nissan Motor Company Annual Reports.*

Yet sources of these efficiencies are also sources of risks in the sourcing process. The strategic objectives involving risk-reward tradeoffs passed down the management hierarchy become important areas for middle managers responsible for business performance. For instance, organizations are instituting global sourcing operations to benefit from supplier base competencies and efficiencies worldwide; and as a form of entry through a local supplier base in the host country, to penetrate regulated markets for manufactured goods. Balancing these advantages are political, legal, information exchange, currency exchange rate, and logistics lead-time risks that potentially add costs to sourcing programs. Suppliers themselves are subject to sub-contract risks, and these compound risks faced by the original equipment manufacturer, or OEM buyer. While the principle of distributing risks is widely accepted, it may be exceedingly difficult to actually

allocate risks. Determining which risks may be controlled and which are outside the control of suppliers is often a contentious issue. It is usually beneficial to both buyer and seller to determine a general benchmark for cost increase pass through in a price adjustment formula. Once this is done, perhaps through judicious use of contracts, sourcing maintains an incentive for cost control (Klein 1998).[2]

As more complicated business services are outsourced through contracts, management workload within the buyer organization falls dramatically (after an initial hump). Management of transactions within the governance mode of contracts becomes routine. The risk with the function does not disappear and may even rise, but is shouldered by the supplier of the service or product.[3] The reallocation of risk is a major achievement of sourcing contracts, and the long term relationships with the supply base critically depend on perceived fairness of risk-reward tradeoffs.

Functional sourcing has five aims: (a) serve the factory (b) lower unit costs (c) coordinate purchasing (d) integrate cross functional purchasing (e) implement world class supply processes. Implementation is a challenge. Creation of cross functional groups for short run projects is a useful method. Processes of supplier identification, creation of online catalogues, order management, claims management and reporting form elements of "functional sourcing." Functional sourcing is greatly enhanced with e-sourcing solutions that help to aggregate demand for discounts, compress order-processing cycles from days to hours, and facilitate price comparisons. Many details and distinctions are necessary. For example, between outsourced costs and cost of production / manufacturing; strategic and non-strategic; tactical and functional or operational activities; inventory-able and non inventory-able capital expenses; services and marketable items and expendables.

We can contrast knowledge required for functional and strategic activity. Strategic sourcing is concerned with risk-reward tradeoffs that are hidden from short-term application of functional sourcing. Functional sourcing jobs change with the introduction of electronic or automated platforms, while strategic sourcing roles remain unchanged. The sourcing function executive's resistance to change is sometimes perceived as fear of redundancy and loss of control over sourcing processes. More often than not, however, it is actually due to difficult task the sourcing manager faces in separating functional from strategic responsibilities, both for themselves as well as for other managers in the firm (Keough 1993).[4] These considerations on differences between sourcing, procurement, and purchasing are summarized in Exhibit 1.3.

1.4 Conclusions

The changes we observe in the management of sourcing reflect both its strategic value in a new economy, and its functional improvement with advancements in practice and processes. All levels of management are affected by

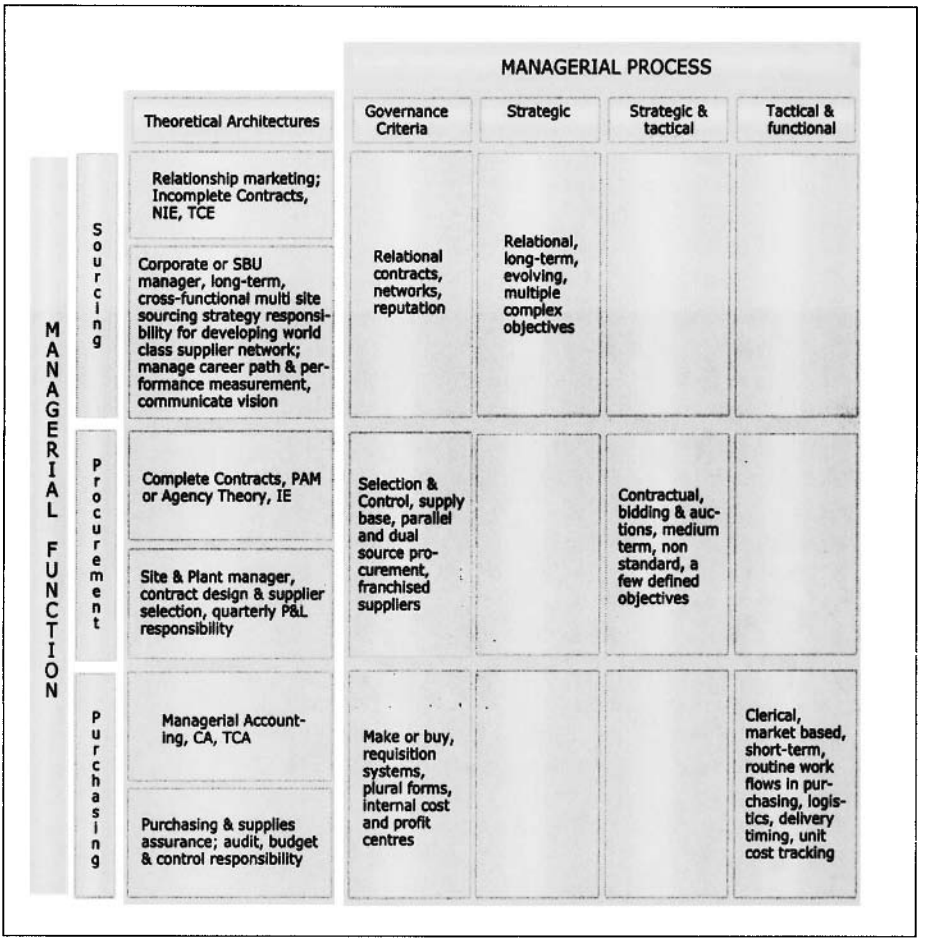


Exhibit 1.3: Re-engineered Levels of Function, Architecture and Process in Sourcing Strategy. The table identifies the knowledge management domains for sourcing strategy. The abbreviations are: CA = Cost Accounting; IE = Information Economics; NIE=New Institutional Economics; PAM = Principal-Agent Models; P&L = Profit and Loss; SBU = Strategic Business Unit; TCA = Transaction Cost Analysis.

the new paradigm. The value proposition for firms is evident in the impact sourcing has on profitability. The strategic perspective covers the longer term and aims at structural improvements in the supply base rather than short term price improvement. Well designed contracts allow better governance of risk allocation between the buyer and suppliers and improved long term relationships. Sourcing in the public interest is similarly concerned with policies and brings enormous scope for change.

The firm's sourcing strategy hinges on a fundamental choice on whether to outsource at all. The decision clearly depends upon the supply base the firm can rely on in comparison to its internal competencies. The larger social issues in outsourcing are challenging ways we think about our firm level choices. Any decision to outsource leads naturally to further quandaries. We next examine outsourcing, and special considerations arising from global outsourcing and multi-sourcing decisions.

2: Outsourcing

2.0 Introduction

Sourcing strategies derive from a basic decision to buy rather than make. A market for intermediate goods emerges from a firm's decision to outsource. A strategic perspective can hardly presume the static existence of an outsourcing market. Just as the decision to enter into an intermediate goods market by a supplier precedes existence of an adequate supply base, the buyer's decision to buy some of its requirements rather than make them all creates a demand for the supply base. What do firms source, why do they buy rather than make, and what is the scope of a firm's sourcing needs? The chapter explores the rationale, scope and extent of a firm's sourcing activity. It assesses the extent of outsourcing across industry sectors today. The activity of outsourcing should be distinguished from the contentious issue of globalization. Outsourcing is too often interpreted only at the economy level as across country boundaries. The chapter then pushes the question of whether to outsource further and asks: If firms do outsource, should they seek one supplier or many? The chapter concludes with a discussion of the classic debate on multi-sourcing.

2.1 Make or Buy

The complexity of the decision on whether to make or buy a component or service in the firm's offering should not be underestimated. The complexity justifies various criteria in addressing the decision to outsource or vertically integrate. How should the firm approach the decision whether to make or buy? Bringing multiple criteria to the decision is better than any one approach.

Cost minimization criterion: A traditional cost based approach to make or buy decision requires enumeration of cost and classification of costs as internal or external; and net minimization of costs is the objective. A basic distinction is between service costs and production costs. When there are more than one service department and production department, there may be reciprocal service costs, as service departments in the firm may need to incur costs to service each other. Production costs draw from each service department, and a service department cost contributes to production costs net of its own cost. When production or

service is outsourced, therefore, these reciprocal service costs are affected as well. Consider other divisions' costs while outsourcing. The cost structures change when other divisions have to split overhead costs, and loss of internal demand. There may be checking costs and switch over costs that a division may hoist on other divisions due to its outsourcing.

The external service department when it exists can reduce production cost. The outside purchase is made when it is less than internal service cost. But the level of internal service is reduced by outside purchase. The opportunity cost of any service acquired outside the firm becomes its market price.

If the quantity is purchased externally the firm's fixed cost becomes avoidable, and is not incurred. If fixed costs are being ignored in the make or buy decision, the firm is obviously over capacitated. Fixed costs reflect the capacity to operate. The fixed cost associated with equipment used in services will be included in contribution margins that the external service provider uses to determine its prices. These are avoidable as they clearly will not be incurred by the firm internally for purchased items. Some non variable costs are converted into variable costs by the purchase. The firm must consider avoidable non variable costs in any decision to purchase external services. An integer programming approach can solve this model for quantities to be made or bought.

Profit maximization criterion: The cost minimization approach does not generate opportunity costs of service or production department limitations. Focus on profit, however, raises concerns that lead to a constrained maximization problem. Profits are contribution margins of each production unit over total costs of production or purchase. The constraints are capacity limits of service departments.

When any one department is operating at capacity there are two effects: (a) opportunity cost of profit foregone; and (b) loss in contribution that would meet some fixed cost of capacity. The opportunity cost approach to internally provided services cannot be ignored. The issue is quite common judging from frequent additions to capacity in some service departments in the economy (Manes, Park and Jensen 1982).

Capabilities criterion: The capabilities approach argues that the most capable – supplier or firm – should undertake the activity, and this leads to either outsourcing or vertical integration. Evidence exists that a capabilities explanation is as important at least as a transaction cost explanation. Transaction costs combine with qualitative considerations on capabilities for make or buy decisions. The stage of production and strategic intent in acquisition of capability are also relevant. Customer access may be a consideration. The technology and product allow the firm access to customer behavior in purchase and use. Customer knowledge is used for core technology applications and benefits from proprietary knowledge marketing. This is related to spillover of knowledge from generic activities that lead to serendipitous knowledge. Capabilities and the time required to acquire relevant knowledge partially determine the outsourcing decision (Argyres 1996).[1]

Transaction cost criterion: Comparative contracting recognizes that transaction costs of competing with peers may prevent firms from replacing economies of scale available to a supplier who meets demand of peers. In-house work requires a high degree of human asset specificity. Asset (human and equipment) specificity and site specificity dictate the degree of in-house production. Adaptation needs and incomplete contracting that may give rise to transaction costs also drive firms to vertically integrate away from outsourcing. In larger bureaucracies, incentive is often difficult to maintain internally and outsourcing allows the risk incentive tradeoff to be improved. Sometimes a co-sourcing policy with internal and external suppliers may help balance transaction costs. In franchising, a mix of company owned and franchisee owned outlets is often the case due to tradeoffs in internal and external agency costs (Seshadri 2003).[2]

Substitutable risk criterion: Outsourcing allows external agency to substitute, at least partially, internal agency. Selection risk and other forms of incentive risk may be beneficial for the firm. For instance, risk of non selection may drive better performance than incentive risk-rewards in presence of repeated requirements. The firm could introduce a relationship risk when there is a larger supplier base that values relationships. Then outsourcing will allow better results as relationships may be transferred to other suppliers. In-house incentives could be inferior as the internal supplier is not under direct threat of losing business. Relationship risk increases when production is low volume and high value involving experiential skills and many intangible knowledge assets. Substantial amount of returns on capital employed by the supplier is at stake when the buyer moves its business elsewhere.

Organizational relations: Firms outsource highly labor-intensive operations due to the reduction in organized labor components that comes with outsourcing. The contracting to smaller suppliers who do not carry fixed costs of employee benefits, or are more flexible in their labor policies is often a reason for outsourcing. A typical reason is that employee health insurance costs may be higher in large firms. Smaller firms may be unable to provide such benefits due to inability to pool risks across their smaller labor forces. Another source of lowered employee costs may particularly arise across borders. In some countries labor may not have won concessions through collective bargaining processes, or wages are generally lower. Accounting systems are particularly cumbersome when they handle government and private businesses, and outsourcing to smaller suppliers reduces the load (Argyres 1996). Once the "buy" decision is made look to differences in what organizations buy.

2.2 *Types of goods procured: direct, indirect, capital*

How do differences in what is bought affect sourcing? First, let us examine some preliminary differences between sourcing processes. Sourcing processes for

goods are usually classified as direct materials sourcing, indirect goods sourcing and capital goods sourcing. Direct goods, sometimes also called production spend, are raw materials, chemicals or intermediate products used in manufacture of the firm's products. These could also include freight and logistics for specific product lines. Together they usually account for over half of the total spend. The sourcing of direct goods is viewed as a variable cost as these goods are directly consumed in the firm's product or process. Savings in these direct costs could lead to higher per unit margins in price of the product. These sourcing processes usually are industry specific, and suppliers are specialized distributors, value added resellers or manufacturers from industry verticals.

Indirect goods are consumed as overheads or are necessary for the firm's functions, such as utilities, office supplies, or MRO items such as bandwidth, telephony or electrical power, binding, bagging and packaging materials, electrical load center switches, or furniture. Sometimes also called non-production spend, indirect goods could also include some services such as marketing and advertising, and administrative spend such as hotels and travel. Their costs are allocated to specific product lines through administrative fiat. The sourcing of indirect goods is often aggregated across product lines of the firm to enable discounts from bulk purchasing. However, it is difficult to determine total requirement unless ERP systems are in place. These processes draw from horizontally integrated suppliers such as diversified cross-industry retailers.[3] Capital goods are big-ticket items that will be depreciated over a period of several years, such as office equipment or shop floor machines. Sourcing of capital goods requires detailed value-in-use analysis over lifetime costs and benefits of the good. They enter the financial statements as depreciation and amortization of assets. Functional sourcing improvement programs usually begin with indirect goods and move to direct goods and capital goods. While these terms are convenient for the classification of goods, increasingly businesses also outsource services.

2.3 Types of services, BPO

The sourcing of services is growing much faster than the sourcing of goods. Business processes outsourcing (BPO) has been practiced for many years in a few selected functions. For instance, marketing research had been outsourced to full service MR firms for decades. So also advertising and promotion activity had been outsourced to branding and media experts for many years. What is new today is the degree and scope of outsourcing as a strategic option for firms along all processes in the value chain. Information technology (IT) services are outsourced and many of the information intensive services that ride on IT infrastructure become candidates for outsourcing as well. The call center that logs incoming customer service requests, outgoing telemarketing and in-house order or service execution may be outsourced today to firms specializing in these

activities. CRM may be outsourced to companies with capabilities in Business Intelligence. These business intelligence (BI) competencies require data warehousing, data marts, data mining and marketing decision-modeling expertise. A spend management systems could itself be outsourced, which makes sourcing of procurement systems a valid exercise. The gains from outsourcing these activities to specialist firms may be substantial.

BPO requires the firm to critically evaluate suppliers of these kinds of outsourced activities on multiple dimensions. Service quality is monitored whether outsourcing may be on a one shot or on a continuing basis. Price pressures are a continuing issue. Firms often rely on suppliers for design and development of specific process innovations. Regulator compliance for goods and services included in the BPO is a crucial determining factor in supplier qualification. Often quality certification obtained by the supplier is a deciding criterion. Sourcing of BPO services is therefore fraught with several additional strategic considerations over those shared with sourcing of goods. Moreover, services outsourcing has sparked a much debated topic in the public press.

2.4 Outsourcing

Sourcing from suppliers, vendors and providers of services and solutions is referred to with the catchall term of outsourcing. In recent years the scope and degree of the firm's involvement in outsourcing has grown due mainly to two reasons. These are decreases in transaction costs; and increased efficiencies from focus on competencies of suppliers. This realization for competitive strategy is relatively non-controversial. When outsourcing is across borders, however, it has often led to controversial globalization issues in recent times. The observed growth in cross-border business relationships is due to need for increasingly specialized supply bases, lowering of a variety of global business barriers, and integration of economies world-wide (Granovetter 1985). What is the scope and extent of outsourcing by firms? Recent debates have cast global outsourcing in political economy terms, and ask whether limits should be set.

The degree of outsourcing therefore has relevance to questions of business and economic relations within and between countries. Outsourcing may be of Goods (merchandise and manufactures) or Services (Business Processes and other commercial services) consumed by firms, or imported by a country. Whether domestic or international, the generic classification is often used. From domestic economic development and global business viewpoints the degree of outsourcing may require different analytic considerations. The unit of analysis is clearly different at the firm level and at the economy level. The degree of data aggregation and determinants of outsourcing are different. There are two sets of literature on outsourcing that relate to either the firm level or the economy level. However, there are similarities in basic economic arguments of efficiencies of outsourcing. Moreover, in the aggregate it is combined firms' cross border

outsourcing that constitutes a large portion of the country's outsourced economy – or what is called its import demand.

What determinants of outsourcing across industries can be readily gleaned from available information? At the economy level cross border outsourcing research has focused on elasticity of import demand, as it is usually referred to in the literature. Labor prices, domestic sales and export prices, as well as across the board tariffs on import prices are other determinants of import demand elasticity (Lawrence 1989).[4] The import demand into an economy is the aggregate import demand of profit maximizing efficient firms in the economy, and is assumed to go entirely into the aggregate production economy of the country, rather than for consumption. Moreover, the production economy is measured in the literature by GDP.[5] Research has shown that within an economy the own price elasticity of import demand varies by as much as -.9 to -1.0 (Kohli 1978). Consequences of import demand elasticity that have been studied are its effects on exports and its effects as a substitute to labor and domestic demand. Previous work cited examines import demand from a longitudinal perspective. Then the negative and substitute nature of import demand elasticity with labor and domestic production raises fears that the economy may be excessively outsourcing across borders. This longitudinal approach benchmarks comparisons within the economy, and the analysis is based on time series data (Aw and Roberts 1985).

The nature of the import is important, as imports early in the value chain may be complements to labor; and those later in the value chain may be substitutes to labor [ibid.].

While these elasticities are derived from a time series study within an economy, a cross sectional study provides additional insight. We argue that while these factors will no doubt account for variation around the mean for any given country, mean import demand will be determined by efficiency and effectiveness of the economy itself. We cannot take for granted existence of a specialized supply base within the economy, or that suppliers will find it attractive to enter sourcing business and build capacity.

Let us turn to the disaggregate unit of analysis, the firm level. Outsourcing is an important issue for firm level strategic decision-making, and has been recognized as such (Quinn and Hilmer 1994). Firms seek to focus on core competencies and outsource business processes and value chain activities that are not central to these competencies. At the firm level, research on banks' decisions to outsource IT services showed that banks responded strategically to assessments of relative gains in production economies (Soon and Cummings 1997). Other firm level research demonstrates that low asset specificity leads to increased outsourcing (Walker 1994). These determinants are difficult to identify across firms or industries and are not easily observable without special survey instruments.

Most firms outsource much of the materials and services they use in creating value for their consumers. The industry vertical in which the firm offers products and services has a structure that would be characterized by its life cycle. Mature

industries are particularly concerned with advantages derived by this focus on competencies, as they would likely face higher competitive pressures and enjoy smaller profit margins; and have suppliers that are better organized; or face a greater degree of technological change (Porter 1985). While firms within each industry would aim at different competitive advantages, and would be characterized by differing performance variables, the first level effects on degree of outsourcing would likely be due to industry structure itself. Industries would likely differ widely in the level of outsourcing by their firms.

Is there a determining relationship we can identify for the firm's degree of outsourcing within an industry sector? The literature has identified latent effects such as production economies and asset specificity. It is likely that high production economies will be related to efficient assets; and it is also likely that high asset specificity will be related to asset efficiency. Asset efficiency may be measured more directly with return on asset data commonly available from firm financial statements. Since firms with a higher efficiency of asset use would likely produce more value within the firm, they would outsource relatively smaller proportions of their revenue. *The firm's degree of outsourcing is negatively related to its asset efficiency.*

How does the degree of outsourcing vary with industry? Some insights are available from preliminary analyses of an appropriate database. Compustat® dataset reports financial information on thousands of firms across the world. The highlights for our dataset are:

- 16,072 public companies
- Dozens of industry sectors
- Americas, Europe, Asia, Africa, etc
- Data from April 2003
- 3 Year averages where applicable
- Selected firm level variables

The study interprets the degree of outsourcing as the proportion of cost of goods sold of total revenue. In summary, percentage of cost of goods sold of total revenue for the firms with completed data in the dataset had a mean of 52 percent; and the largest category of firm outsourced nothing. This comprised mainly of insurance firms and some securities trading entities. Excluding this no-outsourcing group, firms most frequently outsourced about 75 percent of their revenue.

A wide range of outsourcing behavior is evident. What are industry sector level differences? A view of sector level average outsourcing by firms is provided in Exhibit 2.1. The median outsourced percent by sector ranges from the low 30's to the low 80's, which is an extensive range.

Clearly, knowledge of the sector of industry is important in establishing any benchmark for the firm's chosen degree of outsourcing. It appears that the degree of maturity of the industry would raise the percent outsourced. Industries such as IT are relatively younger than construction businesses. A firm level regression across all sectors yielded a positive coefficient that represents elasticity of

insourcing to return on assets. This result across all firms implies that as asset efficiency rises the percent outsourced falls. Overall, an increase of ten percent in asset efficiency leads to a decrease in 1.4 percent in the level of outsourcing. [6]

Outsourcing as asset divestment: Overall, the degree of outsourcing is enormous and varied. Concomitant advance in sourcing technology is a major driver of outsourcing growth. Types of goods and services sourced differ among sectors and greatly influence the degree of outsourcing and its success. The variety and scope reflects sector differences.

Industry Sector	Industry code	Number of firms	Mean	Median
Application Software	8130	336	34.62	30.69
IT Consulting & Other Services	8120	687	39.02	42.57
Diversified Commercial Services	6260	439	50.01	58.34
Packaged Foods	3040	446	54.89	65.39
Building Products	6180	345	53.23	65.82
Industrial Machinery	6220	687	54.51	66.37
Electrical Components & Equipment	6190	741	60.30	68.60
Construction & Engineering	6071	549	64.61	82.74
Total	All	12,362	52.36	63.38

Exhibit 2.1: Percent outsourced merchandise and manufactured goods (COGS) of total Revenue. Compustat® data. The sample was broken down by industry sector. The mean and median percentages indicate degree of outsourcing. *Source: An outsourcing dilemma: When to say "when"? http://www.acquinas.com/Papers/*

Asset efficiencies differ across sectors and firms as well, and influence the degree of outsourcing. When assets are a sunk cost, firms considering outsourcing must evaluate their options of whether to divest the asset to an established supplier or to a new one. The asset disposal and input outsourcing decision is not independent of how input prices will be determined in the long run.

One scenario is when input prices are linear, and taken as given once the asset that produces the input is outsourced. Then double marginalization, the sub optimal outcome where both supplier and buyer add their margins making the final price depart significantly from the coordinated or integrated price, wipes out advantages of asset divestment to an established supplier. It is however unlikely that the sourcing exchange will be restricted by linear pricing. The buyer could bargain for a variety of contract terms. When nonlinear pricing contracts with the supplier can be negotiated, the buyer may find it advantageous to divest the asset to a monopoly supplier who can make more profits from other downstream buyers (de Fontenay and Gans 2004).[7] In due course, this bilateral scenario is unlikely to sustain. There will often be entry by multiple suppliers once the asset has been outsourced, and the buyer would replace bargaining by the more efficient competitive bidding process for price discovery. It would therefore be necessary for the farsighted buyer who divests assets to trade off the discounted value of such a monopoly supply strategy that maximizes asset value with advantages of a divestment strategy that gains multiple suppliers.

Outsourcing as buffering: One explanation of the historical trend toward outsourcing comes from risk buffering. The management function provides buffering from risk for large centralized and integrated firms. However, decomposition of organization into markets is replacing the buffering owed to human cognition in the management process. The overall thickness of markets is far greater than phases prior to emergence of the large conglomerate. The supply bases form and evolve more rapidly. The ground is now fertile for outsourcing as buffering from outsourcing particularly helps in the ability to spread risks.

The transformation of business structures though outsourcing comes from proliferation of outsourcing frameworks. These facilitate development of tradable units from what is an integrated production. The advantage is increase in throughput capacity. The modular system of design and production is a big step in this direction; so is standardization. Information dissemination has ambiguous effects, as it could make internal organization more efficient as well.

Is outsourcing here to stay? One answer is in the affirmative. Taking a historical perspective the... "visible hand – understood as managerial coordination of multiple stage of production within a corporate framework – is fading into ghostly translucence."(Langlois (2002; p.2).[8]

Outsourcing and specialization: Can outsourcing ever be socially undesirable? The success of outsourcing is due to interplay of improvement due to specialization with other reasons such as lowered wages of outsourced labor, and economies of scale that the outsourcing contractor may enjoy with demand. Specialization often leads to standardization of inputs that reduce diversity in the final product. The social benefits of outsourcing may diverge from its benefits to the firm when desirability of R&D and product diversity is not taken into account. As externalities they can reduce welfare, making outsourcing socially undesirable. Large firms in a vertically integrated regime may perform more R&D than smaller firms in an outsourcing regime. A greater variety of products

can change volumes available of each and impact product class growth rate. It is not obvious what the social desirability of outsourcing will be without considerations of consumer tastes for diversity in final products (De Groot 1998).

With specialization and R&D investments come two attendant problems. One, possibility of a failure in the search and matching process required to find the specialized supplier; and two, possibility of incomplete contracting and hold up problems. The cost advantages and bargaining power of input suppliers interacts with competitiveness of the final product market. When the former are two low and the latter is high, outsourcing will be minimal. Studies of the printing industry show that intent to outsource falls significantly due to fear of opportunism arising from incomplete contracting, and due to the switching costs that come with search problems (Verwaal, Verbeke and Commandeur 2002).[9] In turn, this results in a low degree of product differentiation. Specialization of intermediate inputs is reduced by the need of component suppliers to raise their bargaining power in incomplete contracting environments. The extent of outsourcing balances these forces (Grossman and Helpman 2001).[10]

With such search and incomplete contract environments, thicker outsourcing markets (more input producers and more input seekers) are more profitable. This is termed the thick market externality. At the level of city or county economies, agglomeration of firms and specialization offers these externalities. One study found that doubling intensity of demand for a service in a county, for instance, could increase probability of outsourcing by firms in that county by as much as 25 % (Ono 2001). The externality leads to domestic and international outsourcing possibilities that differ. The imbalances in technologies for search and investment, and the fraction of investment that is contractible differ among international locations. This leads to different locality concentrations of outsourcing (Grossman and Helpman 2002).

Outsourcing may be from a supplier, a buyer, a competitor or a collaborator. Quite often a supplier of an input can be a competitor in a downstream market for the final good. The complexity of multi-market competition makes the relationship open to question. The ability to collude with a competitor in one market may either soften or enhance competition in another downstream market. If the subcontractor has the potential to compete will outsourcing be wise? Should the buyer ever outsource to a potential rival? Such a scenario leads to a form of coöpetition which is likely when synergies can benefit firms. Total welfare could rise from outsourcing and both consumers and firms can benefit (Furst and Melumad 1999).[11] The incremental rewards from synergies can more than offset losses from competition, as the cost-benefit tradeoff is no longer a zero sum game.[12] Booking capacity of the supplier reduces its ability to compete in the downstream market. The gains from lowered competition with the final product can offset lost margins due to an outsourced portion of intermediate production, or due to higher prices for inputs. With so many parties potentially involved in even a single tier of sourcing it is important that the processes for tracking interactions be sophisticated.

2.5 Processes and technologies

Just how sophisticated are sourcing technologies? Sourcing processes and technologies have evolved considerably in the last two decades. The early 1970s led to emergence of electronic data interchanges (EDI). EDI was a transaction specific investment. The 1980s saw emergence of the Internet and electronic communications that were not transaction specific, but were IT enabled. Early supplier involvement (ESI) in design modifications and delivery processes became easier. The late 1990s witnessed vastly superior enterprise wide process digitization. The e-sourcing era had begun. It was possible to blur the lines between firm and supplier, the buying center and the selling center could cross firm boundaries, and processes could be configured across the supply chain. New hardware systems, such as Cisco® routers and client-server architectures, and software systems and programming languages, such as Java®, enabled these changes. Widely dispersed locations became part of the same sourcing net, as geographical distance and computer technology standards lost their nuisance value. New languages that made this possible allowed instant reconfiguration and customization of buying processes, cutting delays from days or weeks to hours.[13] The cutting edge and future developments in sourcing include web exchanges, special software applications and expert systems for diverse and complex business processes outsourcing, enabled through online multi-dimensional contracting and auctions.

Paperless sourcing is enabled by the company's ERP system. Business data mining and online analytic processing (OLAP) systems allow the sourcing analyst to benchmark category spends of global companies from locations around the world. Data mining allows access to buyer data-warehouse for indirect spending and direct spending information. The former is fertile ground for cost reduction, while the latter may well be monitored already. Terms of contracts, rebates, volumes, and performance measures are required for information to design better contracts, volume allocation, and incentives. Most ERP systems alone don't capture discovery processes to the level of fine grain that is needed – which means that spikes in local prices, new vendors entry, etc., are not captured and used for contract adjustments. Data warehousing allows buyers to integrate general ledger, accounts payable, and ERP data on vendors. Automated sourcing systems are not about workflows, authorizations, and aggregations alone. Their aim is to arrive at and enforce price and non-price attributes, and vendor as well as buyer training is essential.

Best results come from technology, category specific content and analytics – at all three levels. Analytics solutions are necessary to aggregate, organize and normalize multidimensional sourcing data. Category intelligence for thousands of back end data points necessary for price performance analysis, contract choice, and vendor selection. Sourcing technology is necessary to log data from high

volume bid collection, conduct management interventions and analysis, and to cut time by half for vendor operational data access; and accessible web based purchasing software that allows indirect spend data collection and analysis is help. The systems must have embedded contract pricing to set price ceilings and highly detailed and customisable report templates that help responsible managers to monitor in depth (Weeme 2003).

In sum, the communications revolution and convergence of communications and computing has lead to entirely new value networks approaches to business sourcing (Holm, Eriksson and Johanson 1996).

Now that the reasons "why" the buy decision is chosen, and the nature of "what" is bought is clearer, we may begin to ask "how" sourcing is done. The next section discusses an important theme in this book of how strategic considerations determine sourcing.

2.6 Multiple Sourcing

A classic sourcing question for buyers is: Should we single-source? Classification of the buyer-supplier relationship on preference for a single supply source versus multiple supplies of sources is "potentially a very useful basis for market segmentation" (Segal 1989). In fact, several scholars have noted quite early that the predominant strategy is multiple sourcing with typically two (dual sourcing) or three suppliers active at any time.[14] Multiple sourcing is frequently observed in practice in both industrial and government markets when there are inherent uncertainties in products or services sold. Frequent multiple source procurement arrangements prevail in engineering, manufacturing and financial capabilities. These have high uncertainty relative to commodities buying. Competitive awards to multiple sources are reported to exceed 50 percent of the defense sourcing budget in 1987. Share of business allocations exist among multiple sources for products with uncertain costs. Supplier prices and shares are related to strength of the desire of the buyer for multiple vendors. The typical aerospace project of Department of Defense is a design competition in which usually two firms are funded to independently produce competing proposals with prototypes.

Dual sourcing, where the contract is split between two suppliers, enjoys a special position among multiple sourcing awards. It allows most essential strategic advantages of playing suppliers against one another in a cost containment contest, while reducing administrative drawbacks of too many suppliers. It also retains as much of the economies of scale as possible, without actually single sourcing. Of course, teams and cooperative sourcing arrangements are possible only with multiple sourcing arrangements.

Outsourcing to multiple suppliers may have the advantage of attracting entry. There is a secondary effect of greater entry leading to more outsourcing. Especially when buyers share their multiple suppliers the resulting increase in

demand from the supply base leads to economies of scope. The efficiency of outsourcing is therefore reinforced by further entry and further outsourcing. The interaction between the make-or-buy decision and the entry decisions positively reinforces the intermediate market. Providing access to designs to multiple suppliers is a step toward multiple sourcing, and has the benefit of mitigating hold up problems in an environment of incomplete contracting. Buyers too make higher investments when the number of their suppliers increases. When buyer's outputs do not compete with one another there is an argument for developing a supply base that shares input outsourcing among peers among buyers. This encourages more investments from suppliers as well, although when a single buyer is available suppliers will reduce their investments. Two effects with economies of scope for the supply base that offsets decreased investment with rival suppliers are (i) set up costs are distributed over more designs; and (ii) designs have spill over effects between one buyer to the next. The downside with economies of scope is that standardization leads to less input customization (different from earlier noted loss in product differentiation when buyers compete). Less product differentiation leads to more intense competition in the final product market, and offsets some gains for the buyer from outsourcing (Levy 2004).

Even with a single buyer there are several arguments for multisourcing. The central question for a given buyer usually is "how many suppliers to select?" In this book, we examine several approaches to answering this question, arising from different tradeoffs between number of suppliers and cost structures (see Baiman 1982; Demski and Kreps 1982).[15] We specifically examine the tradeoff between transaction costs from adding suppliers, with benefits derived from a variety of sources.[16] The fundamental argument for multiple sourcing is that it should occur when the market could not otherwise support competition in the long run. There are several specific ways a deeper understanding of multiple sourcing helps improve competitive sourcing, and here we mention what might qualify as "top ten" reasons.

The first has to do with whether the numbers of bidders who compete can be increased by reducing risk of non-selection. An example from the construction industry makes explicit the importance of the number of bidders (Rothkopf 1983, p.107). In this example, a bid taker (the buyer) was faced with an operational question of whether to delay a project in order to allow an additional bidder to prepare a bid or proceed with the best of the bids it had already received. "The cost of delay was easy to estimate, but what was the cost of doing without an extra bidder?" Increase in the number of bidders is the single most important feature of sourcing, when compared with the nature of contract incentives, self-selection by bidders into terms of contracts, or buyer degree of commitment to terms of the contract (Bower 1993).[17] Bidders are more attracted to competitions where there is lower selection risk. Multiple sourcing allows more than one supplier to succeed in the bidding competition and thus reduces selection risk.

The second argument concerns insurance a buyer needs against possibility of stock out. Early recognition exists of the so-called stockless purchasing

agreement found especially in industrial components and sub assembles that tend to "lock in" organizations to their present vendors (Webster 1984 p. 49).[18] Transaction cost economics terms these as hostage situations. Buyers face the risk that unanticipated surges in the sourcing requirement could lead to hostage crisis situations if there is no pool of suppliers with installed capacity of sufficiently large magnitude.

A third argument is that multiple sourcing offers the buyer the opportunity to manage supplier behavior after awarding the contract. Inevitably, the role of cost control is a central issue. Problems that are moving industrial buyers towards dual sourcing, such as difficulties with supplier provided cost data, misdirected cost reduction efforts, and costing of innovations (Newman 1989). Dual sourcing offers the possibility of contests between suppliers, providing performance incentives that help balance higher bid prices. The possibility of introducing some form of competition between selected suppliers in order to provide incentives for post-award cost control is simplified and more direct when multiple suppliers are chosen in the initial selection process. Tournaments and contests in face-to-face competitions also strengthen incentives to invest in incomplete contracting situations. Seshadri (1995) shows when dual sourcing provides additional incentives for cost control, while reducing insurance required against uncertain costs. Konishi and OkunoFujiwara (1996) show tournaments develop endogenously. They justify two potentially competitive suppliers rather than a single supplier in new model development by Japanese auto assemblers. The efforts suppliers make in quality enhancement is another post award issue, as experience with supply accumulates. Industry uses hybrid systems that procure from multiple suppliers and lead into sole sourcing once satisfactory continuous improvement programs are in place (Deng and Elmaghraby 2002).

Fourth, alternate suppliers play a balancing role in long run relationships. Collusion between personnel across firms in long-run buyer-seller relationships could lead to inefficient sourcing and that might make a breach with existing suppliers desirable for a buyer (Tirole 1988, p.27).[19]

Fifth, policy often requires multiple suppliers. Cost escalation in government sourcing is in part attributable to a lack of alternate sources of supply. After the award is made, a monopoly situation evolves and prices tend to rise severely.

Sixth, risk sharing among suppliers emerges as a possibility under special contracting arrangements with multiple suppliers. Syndicates of suppliers could share risk horizontally and therefore bring efficiencies to competitively bid procurements. These efficiencies will manifest in lower prices for the buyer.

Seventh, some sourcing situations may bring about diseconomies of scale for the seller, especially when capacity constraints are present. Many smaller suppliers are already operating at decreasing economies of scale (Basu 1996).[20] When conditions for a natural monopoly do not exist, or when supplier capacity constraints exist, there may be decreasing returns to scale. Multiple sourcing allows the requirement to be split among more suppliers and increases slack

capacity for any particular vendor. In the long run this may even help increase capacity in sourcing business, or maintain capacity more efficiently.

Eighth, dual sourcing provides some disincentives for excessive direct labor expenses and corresponding overhead allocations to government contracts when cost based procurements are in place, and suppliers engage in both government and commercial business (Rogerson 1992; Cohen and Loeb 1990).[21]

Ninth, use of teams may be possible or inevitable, and team incentives that lead to collaboration among suppliers may be possible. Resource sharing between clusters of suppliers with differentiated outputs in full information environments could be preferable due to advantages or synergies from pooling resources (Gupta and Seshadri 1994).[22] When there is a team output that is not differentiated and unobserved and unverifiable effort (or moral hazard) problems exist, these team arrangements are not always preferable. The problem of "free riding" by some team members can be acute, and the need arises for a principal who can perform "budget breaking" functions, such as punishing the entire team or rewarding the entire team on evidence of work aversion (Holmstrom 1982). Moreover, collusive strategies may sometimes be optimal for sellers, ones that the buyer would certainly not prefer (Itoh 1991).[23] Adding initially unobservable abilities create a supplier selection problem for the buyer that results in some additional considerations. However, a contract linear in team output is optimal under these conditions, even when the suppliers are risk neutral (McAfee and McMillan 1991).[24] When additional activities are possible for agents that yield better compensation, such as quality control and maintenance of private capital assets, suppliers could shift attention away from team activity that is poorly measured, and base compensation on individual contribution (Holmstrom and Milgrom 1994). Peer pressure within the team is an additional activity that might mitigate the problem, and success of peer pressure would depend upon the number of agents and standards they set for their team members (Barron and Gjerde 1997).[25]

Finally, multiple agents allow the firm to telescope hierarchical tiers. The buyer then deals with multiple suppliers directly in one flat layer rather than have sub-contracting chains in hierarchical layers. When production levels needed rise due to market conditions the buyer often finds it easier to hire more agents, despite a monitoring cost associated with more agents, than to increase effort levels of risk averse agents who have increasing effort costs. Balancing hiring of more agents are problems of additional monitoring costs, and of greater noise or loss of control in identifying a signal for each agent's output (Ziv 2000).[26] In the extreme loss of control may result in only an undifferentiated team output on which to base compensation.

These are not exhaustive among arguments in favor of multiple sourcing.[27] Sourcing is rich in functional and strategic choices. The modern imperative of sourcing reform is taking hold as a natural consequence of economic and technological advances. The sourcing manager's role is now a strategic boardroom role that affects how the entire firm or corporation does business. One

consulting house sums this change as: "Procurement offers a rich source of options for reshaping a business from the inside out and builds new forms of competitive advantages."[28]

2.7 Conclusion

The most important decision for the creation of intermediate markets is the make-or-buy decision. Many considerations come into play when a firm decides to outsource. However, the extensive nature of the outsourcing market is evidence of prevalence of the "buy" decision in all sectors of the economy. Globalization, or the spread of intermediate or consumer markets across international boundaries, is often confused with outsourcing. The order of magnitude difference between the two comes from aggregation of firm level inputs for economy level imports. Sourcing strategies at the firm level are faced with strategic questions at a disaggregate level. A key issue is whether the firm should multisource. Several arguments in favour of multisourcing reveal the strategic nature of the sourcing process.

We should now aim at a coherent structure to reveal strategic interactions within the whole sourcing process. This is a tall order and calls for a constructive approach to the challenge. The architecture in the next chapter provides a set of principles that guide policy for the whole sourcing process.

Top Ten Myths of Cross Border Outsourcing

#10: Outsourcing equals globalization: These are two different processes that sometimes coincide. Outsourcing breaks out activities in the firms overall value addition that may be better performed by other firms, thereby improving its returns on capital employed. Globalization takes advantages of factors of production worldwide. Some outsourcing is across borders, but is usually within the country. The MNC does not outsource most of its global production.

#9 English is an Anglo-American tongue: British colonization in Asia since the 1700s and the change in isolationist policies of the USA after the middle of the last century have made variants of English a widely used language. European economic integration in recent times has also enshrined English as the universal language of business. This implies that communications dependent business process outsourcing (BPO) through digital media can migrate anywhere. Accents may be local, but the tongue is world-wide.

Top Ten Myths ... (continued)

#8 Job losses are due to cross border outsourcing: Many jobs are lost every year, and other jobs are created. Job loss is due to economic cycles of growth and recession, restructuring in the local economy, creation of new capacity, changing consumer tastes, and better production process replacing the old. Many modern societies have always had stable unemployment rates with new entrants into the ranks of the unemployed. Jobs would be lost and gained even when delivery is from the local workforce.

#7 Cross border outsourcing is a one-way street. Much of the money going abroad to cross border sourcing is finding its way back for complementary goods purchasing. What goes around comes around. Hardware is purchased from local firms for software that is bought abroad. Educational services in local outsourcing markets are a big beneficiary of fees paid by aspirants for new careers from host countries. Perhaps the most important reverse benefit is that a broader based local consumer market becomes possible.

#6 The world is a better place without cross border outsourcing: Countries that are part of global business supply chains are unlikely to find war affordable. This is true of both sides of the border, for the host as well as the local county. Even hostilities affect country risk ratings and destroy value. The traditional cottage industry economy in host countries lost to cross border outsourcing is hardly sustainable even in the most isolated economies. The internal contradictions and competition for resources find pathological expression in isolated economies.

5 Outsourcing is neutral. No technology or process is neutral. There are always winners and losers with change. The losers however are never permanent losers, as change brings new opportunity. Corporations that have gone bankrupt could have been saved by timely BPO. Employees let go as a consequence of bankruptcy should be employed today if these corporations survived. At the same time it is true that other employees have lost jobs due to BPO, as their contributions certainly were superceded through outsourcing. Cross border outsourcing is not gender neutral – women have access to remunerative work of non-indigenous origins that men have not traditionally monopolized.

Top Ten Myths ... (continued)

4 In-sourcing is unquestionably good: In-sourcing (the flip side of outsourcing from the host country perspective) can suffer due to infusions of non-indigenous wealth. Local inflationary pressures can rent the economic fabric. Real estate, for example, can become a bubble market. Public goods and infrastructure provision suffers as they fail to keep pace. Traditional economic niches and cottage industries are destroyed, as are subtle value-systems that may be difficult to replace through marketplace alternatives. Many sociologists and activists consider visible widening and deepening of the tax base from in-sourcing to be scant and lopsided compensation for the potentially enormous loss.

#3 Outsourcing is an option. The belief abounds that lobby groups and legislation will stop outsourcing across borders. This is wishful thinking. Legislation could, and should, regulate *laissez-faire* outsourcing to prevent economic violence on displaced workers, whether from domestic or cross border outsourcing. Voluntary retirement, health insurance, unemployment benefits and re-training must improve. Tax loopholes must be plugged. However, the economics of outsourcing arises from millions of people acting in their own self-interest, and are too compelling not to prevail. In that sense it is a force of civilization.

#2 Outsourcing is zero-sum: The motive force for sustainable outsourcing is innovation. The firm is unable to bring productivity gains in-house. It is unable to anticipate, plan, and create the future of its business process in-house. Value addition and the "next big thing" in the activity are left to suppliers who focus on the specific activity – be it manufacturing, IT services, or hotel bookings. The breakthrough may happen halfway around the planet.

#1 Outsourcing societies are net losers: The jobs that are lost to outsourcing represent wage–rents that are lost. Cheaper goods and services represent consumer surplus–rents. The vastly more consumers than produces of a particular good or service convincingly tip the equation. The manifold gains from consumer surplus represent untold consumer welfare in the society that follows sustainable outsourcing.

3: Architecture and Processes

3.0 Introduction

Sourcing is a process that spans several activities in the firm, and therefore it is of crucial importance for strategy to reveal inter-linkages between these activities. Business processes in sourcing include marketing and purchasing, accounting, design and development, operations management, general management, and business strategy; and several economic concerns are both at industry and firm level. Is there a way to grasp a holistic view of the sourcing process? The principles and policies of sourcing must ensure these concerns are well integrated, and they demand an architecture that encompasses these diverse activities and processes. What are the components of this integrative architecture? This chapter integrates these concerns in business and industrial organization to provide the conceptual architecture for strategic sourcing. It is a bridge between the purely descriptive approach to sourcing and the constructive approach. The chapter ends with an introduction to the academic software package based on this architecture, Proxsys®, included with this book.

3.1 A Rational Architecture

The environment in which procurement and sourcing processes unfold extends from formal clerical procedures to the philosophical management style of firms involved. In this book, we take a strategic view of sourcing that lies in between these extremes. The goals, objectives and strategies to meet these objectives rest on sound principles and polices. The design of sourcing strategies must adapt for specific scenarios. We distinguish between shorter-term evolving governance mechanisms and longer-term relationships between firms in the procurement and sourcing process. As a convenience we shall use the term "procurement" to refer to short run contractual and auction governance mechanisms, and the term "sourcing" to refer to the longer-term process that is supported by procurement. In this section we develop an architecture for sourcing with linked incentive (from contracts) and selection (from reverse auctions) mechanisms. The burden on strategic sourcing, understood as governance mechanisms, is to support relationships. The burden is made more explicit in this section with a subsequent architecture below linking markets, contracts and relationships.

The sourcing market is essentially a result of decisions taken by contractors and sourcing agencies, based on expectations of each other's behavior. Therefore, three domains may characterize the sourcing market: those of the buyer, those of the seller, and those of intervening economic uncertainties. These domains gain importance only because of their interactions. The individuals and teams within these domains often are not even thinking of optimal or efficient actions in a cognitive fashion. Yet, it is institutional arrangements and processes to which these agents are subject that create the "right" behaviors. What is the evidence in favor of this claim? As behavioral validity of the rational architecture of sourcing is a foundation issue a brief answer to the question is appropriate.

3.2 Sourcing Behavior and Rationality

Over the last thirty years corresponding to development of formal models of imperfect markets, there have been hundreds of experiments conducted to determine the predictive ability of these models. Overall, these experiments have found agreement with predicted outcomes. In some sense, it is rational behavior to be rational. The processes investigated in experimental economics show that outcomes of interest rapidly converge to rational expectations competitive equilibrium. While convergence rates tend to vary these results generalize to a wide variety of posted-price and sealed bid awards that we find fundamental to sourcing (Smith 1991).[1] Studies have particularly investigated behavior in risky situations, and asymmetric information trading institutions such as auctions and contracts, and how changes in these institutions influence the match with predictions (Davis and Holt 1993). Particularly in *integrated auctions and contracts* experiments, efficiency losses are well predicted, and relative rankings of incentives and information differences between various institutions match extremely well with predictions (Cox, Isaac, Cech, and Conn 1996).[2]

Our architecture for governance in the short run, therefore, relies on the underpinning of formal models of sourcing institutions, and finds its justification in the broad support of both empirical observations, observed industry practices, and in experimental validation. The architecture for strategic sourcing in the short run is strategic interaction between buying and selling processes in environments of uncertainty and asymmetric information. Our architecture models these interactions specifically through contracting and auctioning mechanisms. Exhibit 3.1 is a basic schematic depiction of the architecture. Subsequent sections elaborate on elements of this architecture.

3.3 Buyer Processes

Let us begin with an immediate consequence of the "buy" decision. The buyer is influenced by several constituencies and differing criteria (reported in Gates

1987).[3] There will therefore be several tradeoffs in buyer objectives, which impact sourcing processes. A major interest is in determining intended and unintended consequences of these tradeoffs.

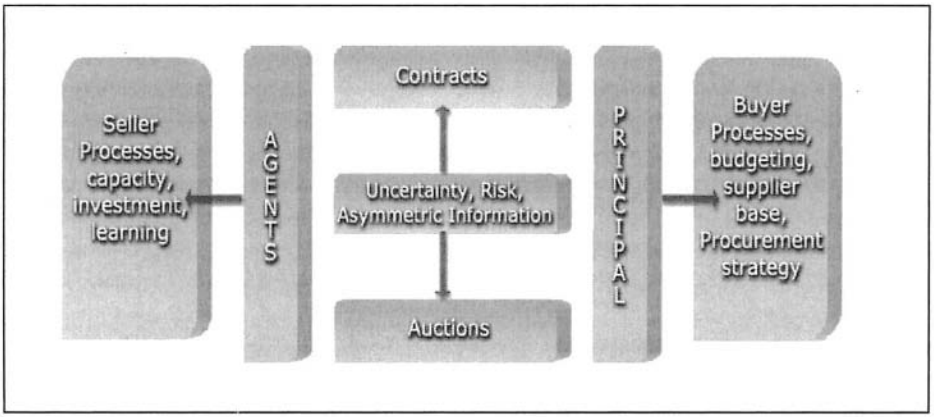


Exhibit 3.1: Strategic sourcing governance architecture. Uncertainty and Risk are intermediate to Seller processes and Buyer processes. Interactions are through Contracts and Auctions. The Buyer is usually acting as Principal and the Seller as Agent in interactions.

The buying process involves several choices. These encompass rules under which sourcing occurs. There are significant pre-bid or pre-sourcing activities undertaken by buyers. The need determination is internal to the buying organization, though incumbent suppliers may well be involved in developing the need statement and even preliminary specifications that go into the Request for Information, Request for Proposal, and Request for Quotation (RFI, RFP and RFQ). Lists of pre-qualified suppliers may exist and are contacted; as well as public notices may be posted. Among the pool of possible supplier's a set of interested sellers would respond with technical proposals, followed with economic or commercial terms.

The process continues with phasing of technical reviews of seller's proposals, followed with economic reviews. The technical review is normally made by a panel of experts and demarcates the range of acceptable specifications. This review selects a subset from among potential sellers and quite often eliminates the lowest 25 percent of them. Remaining qualified sellers may be considered strategic sellers if they take a competitive interest in the bid for economic review, or non-strategic potential suppliers if they do not. Non-strategic sellers are available as suppliers if the sourcing competition fails to yield sufficient competitors. These are analogous to the passive suppliers that often surface from e-catalogue searches. The economic review is usually conducted using a process that converts technical specs, commercial contract terms and bid prices to a "monetary equivalent." The formulae used for conversion is usually well known

by all involved. Therefore, sellers are able to determine their tradeoffs well enough during the sourcing process. The buyer determines whether awards could be made on the basis of these reviews or whether further rounds are necessary. Key decisions for the buyer are whether only clarifications will be sought from qualified bidders, or whether information would be shared with all bidders on competitive bids with a view to seeking revisions. The additional buying process costs over prices are a critical concern for buyers. These process spends could often be as high as those of other market selling processes. Complementary to the "buy" decision is the decision by potential sellers to enter sourcing business.

3.4 Seller Processes

Sellers are either incumbent or new entrants into the sourcing competition. As incumbents, sellers are likely to be intimately involved with developing RFxs and need statements for sourcing and therefore enjoy advantages over rivals. The buyer is usually charged with eliminating these incumbent advantages and leveling the competitive field for all potential suppliers. The formal architecture should therefore not assume that incumbent advantages exist and should view each individual sourcing program as a separate competition between equals. Sellers will differ among each other due to other reasons, such as their costs and their alternatives to sourcing business. The sellers' decision process in sourcing begins with an assessment of the expected value of entering the competition. They weigh this assessment against their alternatives. The decision to participate will then require the seller to perhaps invest in bid preparation, and make some pre-qualifying dedicated investments. These may not be recovered if the award goes to some other competitor. The seller prepares a technical bid keeping the RFx in mind and prepares an economic bid with attendant commercial terms. The bid opening and evaluation process may allow minimal intervention from suppliers, but sometimes there could be scope for information inputs from competitive evaluations requiring re-tendering of bids. Sellers are finally selected and begin with fulfillment activities, and often more than one supplier may be awarded portions of the sourcing program. Procurements could involve a design phase, and a production phase, with interim evaluations of suppliers. Effort supplier spends in various sourcing objectives needs to be part of the decision process, especially if other than cost plus compensation plans are used. Selling process spend is incurred over and above the cost of goods sold (COGS), and are a major area for seller cost control efforts. These cost controls could entail general investment in capital goods; specific investments, dedicated capacity commitments and additions; or skill development for productivity gains.

In some form or other, all strategy has to deal with capacity management. Long-term forward contracts are advisable when firms must invest in large amounts of capital in capacity and face thin markets with few buyers. The firm then has the advantage of in acquiring demand information as well as recovering

marginal capacity costs. Capacity may actually influence future spot prices in these thin markets, and may influence future contracting ability as well. For these reasons it is advisable for the firm to negotiate, or bid and win contracts prior to capacity investments, rather than to seek spot sales after investment in capacity (Parsons 1989). Sourcing oriented suppliers often have to invest in capacity anyway, and very likely their institutional customers will not fluctuate whether these customers procure with spot sales or via long-term contracts. Clearly, it is in the suppliers' interest to seek such contractual award prior to capacity investment.

Capacity constraints in upstream assets that supply multiple downstream buyers are also a related but separate issue, and contractual solutions are affected by the nature of information asymmetry and contractual arrangements. Vertical integration is one possible response, and allocation of capacity is another. The form of response has implications for investment in the asset, and capacity development by the seller.[4] While buyer and seller processes and decisions are complementary, they are typically made in an environment where information is incomplete.

3.5 Uncertainty, Risk and Asymmetric Information:

Buyers and sellers are characterized by their endowments and abilities at the start of each sourcing competition. These are characteristics of the economy and history of the industry. This history may be characterized by an existing institutional structure, leading to an allocation of property rights, existing capacity, and technologies that convert effort into outcomes. The buyer has an initial budget from which acquisition costs will be paid. The sellers are characterized by cost estimates, resource availability, alternative opportunities, risk aversions, or capacity constraints. Often these endowments are estimates from uncertain subjective probability distributions. Their specific characteristics would be learned in the sourcing process by the particular buyer or seller, but would not be known to others. The information structure of the process is constituted by characteristics that are learned, and the chronology with which they are learned during the decision process. Information structures add to transaction costs and increase spending on selling and buying processes. Minimization of these transaction costs is a major objective for scientific sourcing.

Asymmetric information on costs and uncertainty is a key determinant of contract type. The nature of cost asymmetries can determine regions over which one or the other type of contract is preferred, and the specific structure of contracts. The optimal contract may change depending upon the nature of cost uncertainty, asymmetry and risk attitudes of bidders, and whether sourcing is a one-shot or a multi-period sourcing (Vistnes 1994).[5] The seller may not even have estimates in some cases, and will have to spend on information acquisition or planning phases of the sourcing program. This influences the nature of the

optimal incentive contract, leading in an extreme case to super-high-powered incentives – in the sense of paying more than a dollar for a dollar saved (Lewis and Sappington 1997).[6] Contracts are methods of conflict resolution that have become the key to sustained business processes.

3.6 Contracts and Relationships

The continuum between contracts and relationships is currently an important area of research in business and economics (Seshadri and Mishra 2004). Contracts are effective for governance of relationships and evolve as relationships mature. For instance, competitively let contracts blend naturally into negotiated contacts in many circumstances. A robust way of determining sensitivity of contract parameters to revisions in estimates is of great importance for healthy negotiations.

Complete contracts: Strategic thinking in formal industrial marketing models allowed classification of contracts into (a) explicit contracts of the classical kind, of which spot market contracts with full information and institutions of governance without transaction costs were typical; and (b) implicit contracts of the neo-classical kind, of which self enforcing contracts with full commitment and mechanisms that balance risk and incentive tradeoffs were typical. Firms would tradeoff insurance based on their risk attitudes with incentives based on contractual mechanisms under conditions of uncertainty and information asymmetry. Contracts that depended on complete or symmetric information were likely be unrepresentative of reality, and result in loss of efficiency.

These approaches continue to provide valuable economic underpinnings for competitive marketing analyses at the end user level. The analyses of supply chain contracts are only recently finding moorings in partial equilibrium models referred to above. Particularly used is the principal-agent model (PAM) as a normative theory of supply chain contracting of the implicit kind (Tayur, Ganeshan and Magazine 1999).

Disclosure of private information is not enforceable, and often the only remedy to non-disclosure of material information is to rescind the contract.[7] Uncertain costs complicate the contracting process. Even when the supplier is able to determine their cost with smallest possible error, it may be of strategic interest to conceal costs when risk-sharing agreements are in place. Asymmetric information on uncertain costs allows suppliers the possibility of increasing their rents. The essence of free enterprise society is that each party is "entitled to make use of whatever information he has in order to obtain the best bargain he can get; neither party is under any obligation to assist the other party."(Atiyah 1995). This is the reason why risks of cost over-runs would be impossible to contractually insure. The insurer, who may consider any history of cost-over-runs as evidence of moral hazard, decides materiality of information.

Incomplete contracts: Modern systems of production and consumption in intermediate market have evolved enormously. The rise in recent years of supply chain management has demonstrated that especially in business-to-business contexts markets are not entirely one-level competitive arenas but have multi level interactions. The systems and procedures subsumed by contracts continue to evolve, and are required for a regime of checks and balances within the modern complex spread of supply chain structures. The conditions of evolving information structures that characterize supply chains lead naturally to incomplete contracts. The contracts are recognized to be incomplete in the sense that all relevant contingent states that affect the contract cannot be characterized, or even known at the time of contracting, although they may be observed at a later date. Moreover, at a subsequent time these contingent variables may be observed but cannot be verified for use in enforcing the contract. For instance, transaction specific investment made by a supplier in a contracted sourcing may be observed by the buyer, but cannot be verified except at prohibitively enormous cost for contract enforcement by a court.

A descriptive approach to incomplete contracts is Transaction Cost Economics, where incomplete contracting scenarios of business are a central issue. TCE develops many early theoretical constructs in incomplete contracting and provides a broad basis for work linking marketing and economics (Williamson 1986). Recent reviews link key TCE constructs, such as transaction or party specific investments, hold-up costs and lock-in costs, to emergent formal normative models of incomplete contracts. Moreover, use of subjective in addition to objective measures in incomplete contracts aims at overcoming the problem of unverifiability of important outcomes from the transaction (Hart 1995). The construct of trust that is central in relationship marketing forms one subjective measure.

Short-term and Long-term Contracts: The shift in emphasis from to a long-term, durable exchange is particular to relationship marketing management (Evans and Laskin 1994). In repeated sourcing, appropriately chosen punishment strategies will serve to ensure that first-best results (cooperative or fully integrated optimally efficient outcomes) would be sustained even in the presence of information asymmetries and implicit (but complete) contracts. The concern is whether the optimal long-term contract over the entire duration of the relationship can be achieved by a sequence of short run contracts. This is possible when access to capital and rental markets by agents is possible. Interestingly, the agent can exploit the long-term relationship by renting from the principal, or forming equity relationships with the principal, an example of complementarities of markets and long-term relationships.

Repeated contracts: A process unfolding over time has stages of decision making, events occur with learned outcomes, and patterns of behavior emerge. These lead to path-dependent payoffs for parties in sourcing contracts. A meta-view of contracts leads to considerations that play a role in expectations,

especially when complete contracts must repeatedly be chosen in stages of a long term incomplete contractual situation. We describe two of these considerations.

Reputation may be earned from performance outcomes over repeated contracts. The ability of markets to recognize reputation and reward or punish suppliers based on reputation effects is an influence on performance within the implicit contract itself. Outcomes and actions are observable to parties in the incomplete contract but not verifiable by outsiders, and therefore reputation is internal to the contract. When the market may be able to verify actions that lead to poor performance, then reputation may be external to the contract and provide better incentives for unverifiable effort in performance. This is an additional instance of market-relationship complementarities. The ability to use reputation in incomplete contracts is a rationale for repeated contracts of short duration rather than a single long-term contract. In relationship marketing approaches, reputation is derivative from the network within which the dyadic relationship exists.

The level of commitment is highly relevant in situations of long-term contractual incompleteness. Renegotiation of the contracts is always a strategic possibility as unforeseen events unfold. Explicit long-term contracts are naturally useless in situations where renegotiation is possible, and dynamic considerations make commitment impossible. A fundamental question is whether and when a sequence of short-term contracts is preferable to a single long-term contract. Long-term contracts will be optimal in the presence of commitment, but may not be time-consistent in the sense that both parties would be better off if they could renegotiate. The ability to write renegotiation-proof contracts depends on the information available to the principal on agent ability (Laffont and Tirole 1990).[8] Complex contracts contain elements that are renegotiated and others that require commitment. Some specific aspects of transactions will be more easily anticipated and these can be cast into short-term explicit complete contract agreements, which enable other implicit contracts of the incomplete variety. The importance of so doing will rise if other aspects of the transaction are increasingly complex. As transactions become recurrent and less discrete, the more important it is to remove ambiguity where possible through contract agreements.

Commitment to continuity and long-term relationships with contracting parties is a central construct in relationship marketing. The commitment is derivative from interdependence and coordination, which are learned behaviors for both parties. Relationship commitment positively impacts relationship profitability. Understanding between parties might be more important than profitability in creating relationship commitment. Supplier specific investments are credible commitments the buyer makes and serve to increase coordination, buffer against technological uncertainty, and build closer relations in scare skills markets (Gundlach, Achrol and Mentzer 1995).

Contracts and relationships: Agents interact through the price system, but also use a variety of formal and informal non-price instruments and mechanisms to influence decisions necessary for efficient exchange between firms. Contracts are necessary to govern foreseeable and specific aspects of exchange between

firms, and are widely observed. They directly impact business performance in the short-term. Considerations on financial returns net of contract expenses drive practical transactions at highest levels. While contracts may be explicit, they are also implicit and incomplete forms of contracting that lend themselves to longer-term considerations. Relationship marketing management is primarily concerned about this longer term (Grönroos 1995). The duration of the relationship between partners to the exchange may see different forms of contracts over its course. Relationships are necessary to transcend immediate and foreseeable economic concerns, and are particularly important in situations of uncertainty and ambiguity.

Collaboration between suppliers and buyers is growing in response to the need for innovation, investment and incentives on the one hand and rising demand and supply side risks on the other. While collaboration is necessary in modern sourcing there is inherent competition between alternate partners in a multi-sourcing world. In addition, complexity of sourcing arrangements often requires multiple contracts between the same two partners, for separate agreements. For instance development and manufacture contracts with the same suppliers may require two-stage contracting. Sourcing agreements are transactional when they are governed by short-lived arms length contracts of the classical kind with provision for third-party intervention, such as court judgments. Collaboration between suppliers and buyers is growing in response to the need for innovation, investment and incentives on the one hand and rising demand and supply side risks on the other. While collaboration is necessary in modern sourcing there is inherent competition between alternate partners in a multi-sourcing world. In addition, the complexity of sourcing arrangements often requires multiple contracts between the same two partners, for separate agreements. For instance development and manufacture contracts with the same suppliers may require two-stage contracting.

At the other end of the spectrum, the agreements are relational when they are governed by bilateral modes of interaction such as trust, goal congruence, distributive fairness and perceptions of alternatives (Mishra 2001).[9]

Sourcing contract games: Some sourcing agreements are transactional in nature since the items procured are commodities, or since all contingencies in the agreement can be anticipated easily and written into contracts. Paradoxically, a greater ability of buyers and sellers to contract in a transactional mode for sourcing that is routine allows them to develop more complex relational contracting agreements with the same partners based on trust (Williamson 1986). A rationale for this is that violation of trust can now be punished through the contract on a separate sourcing, giving each partner a greater degree of confidence that trust will not be violated. The argument is similar to game-theoretic reasoning on punishment strategies that players may use to threaten an inferior equilibrium for deviations from the Pareto superior outcome (Benoit and Krishna 2000).[10] This allows a superior relationship to be sustained in equilibrium, even though such a relationship may not be one in a sourcing game

without scope for a punishment strategy. The definition of a relationship as a series of episodes, conforming to a repeated game, is part of the conceptualization of relationship continuity (Mishra 2001).

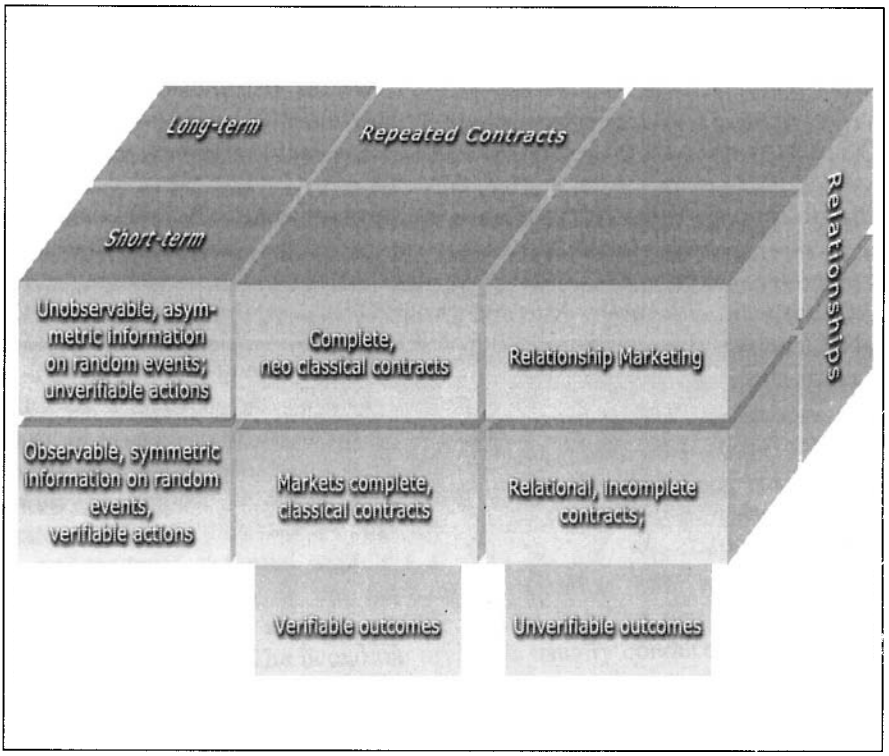


Exhibit 3.2: Dynamics of Markets, Contracts and Relationships. The evolving nature of exchanges between firms requires evolving contractual governance and relationship marketing approaches. *Source: Adapted from Seshadri and Mishra (2004).*

Collateral contracting is an example of such thinking (Macneil 1974; 1978). A rationale for this is that violation of trust can now be punished through the contract on a separate procurement, giving each partner a greater degree of confidence that trust will not be violated (see Benoit and Krishna 2000).[11] This allows a superior relationship to be sustained in equilibrium, even though such a relationship may not be one in a sourcing game without scope for a punishment strategy. A relationship may be conceived as a series of episodes, as the conceptualization of relationship continuity and this conforms to a repeated game. When buyers are unable to commit for long-terms contracts and production learning is possible, dual sourcing contracts reduce the two period repeated contract costs. Exhibit 3.2 depicts our architecture for contracts and their

relationship to spot markets on the one hand, and relationship marketing on the other.

A link between spot markets and contracts is necessary for establishing contractual relationships. A key requirement is a mechanism to deal with horizontal conflicts between candidate suppliers for selection and vertical conflicts for contractual parameters in environments of incomplete information.

3.7 Auctions

A process that elicits customer-specific and vendor-specific information, which may not be readily observable otherwise, would greatly help in contracting. One such process is through auctions, or reverse-auctions. The reverse auction process helps connect spot markets to contracts.

Spot markets: For frequently purchased packaged goods, with a small number of powerful sellers, a large number of relatively homogenous buyers, and with simple low price (and low purchase risk) products, the familiar supermarket environment, with posted prices, works quite efficiently. However, a large and growing portion of annual sourcing expenditures of governments and much of trillions of dollars transacted between businesses is conducted via some form of sourcing competition. In these competitions (of which single-buyer, multiple-seller, one-time, competitive sealed bid case is most frequently cited), potential sellers compete with one another, via bid mechanism to "buy" business. In these markets, the buyer actually constructs the market by defining rules of exchange (open versus sealed bid, single versus multiple sourcing, one time versus sequential, etc.). Sellers enter these contract markets by dedicating capacity, and forgoing opportunities in spot markets.

The standard argument for choosing contract markets over spot markets is the transfer of risk from the volatile, and unpredictable spot market to a more managed risk situation in the contract sourcing market. Therefore, volatility of spot market prices is a determinant of buyer and seller incentives to contract. When shocks to the spot market are due to costs rather than demand, impact is higher on the buyer's profits, and the buyer may favor long-term contracts rather than one shot bidding competitions. Increasing price rigidity, in the sense of departure from spot markets and higher reliance on contracting, is more likely for industrial goods downstream in the supply chain (Hubbard and Weiner 1992).

Other issues may also be important for this transfer away from spot markets, such as information, ability to recover marginal capacity costs, and impact capacity may have on future spot market prices. A key impact is that prior to investment, the seller's reserve price will comprise of production cost and capital cost associated with investment; subsequent to investment, minimum reserve price will fall by the amount sunk in capacity (Parsons 1989). Sellers, acting in their own best interests, respond to sourcing contract opportunities via their

bidding behavior, or via their decision not to bid at all in order to maximize their opportunities in the spot market.

Optimality of auctions: Of all the ways to depart from spot markets, why are auctions and bidding methods popular? There are three reasons why auctions (or bidding competitions) are optimal selling mechanisms. The first, is that at the end of day it is efficient, in the sense that the sale is made to those who value it most; second, it is time consistent, in the sense that it will keep the selling process current until there remains no viable buyer who can gain from trade; and third, of such processes it yields the best expected benefits for the bid taker – i.e., maximizes expected revenue of the seller in the auction, or minimizes expected costs to the buyer in the bidding (Parsons 1989).[12]

Interactive Auctions and Contracts: A competitively bid phase that lead into negotiated profit policy phases has the advantage of engendering more aggressive bidding and greater competition. The "buy-in" phenomenon in bidding is related to the extent of "get well" profit markup that may be expected later, which could be high for a higher cost firm that successfully buys-in. Therefore, the higher cost firm may prefer "handicapping" its bid-profit in order to get its contract policy-profit (or quasi rents) in the later negotiated sole-sourcing situation. In effect the advantage of linking competitive bidding is that firms will bid away their later contract policy-profit in the selection phase (Bower and Osband 1991; Seshadri 1995).[13] As a consequence buyers would prefer to combine bidding competitions with sourcing contracts.

When capacity required by the procuring bid taker exceeds capacity available with any one seller, auctions must necessarily be a multiple source one. When seller capacity is short of required capacity, strategic behavior will ensure that the bid taker must award at its reserve price to get the most capacity it can. Sellers would prefer to combine bidding with contracts when capacity investments are necessary. There are therefore strong incentives to examine bidding and contracting as joint sourcing processes.

Is there an optimal form of contract that should follow the bidding competition? For risk neutral bidders, linear cost sharing in audited costs contracts that follow competitively bid contracts are optimal in many cases, with the proviso that lower-cost bidders accept higher cost shares. In other words, the bidder is allowed to bid the cost share formula as well, rather than to take is as given or fixed by the bid taker (Laffont and Tirole 1987).[14] This is a self-selection feature where the firm can choose its own linear contract from a menu that differs on its sharing rate.

However, estimations from models demonstrate gain from this menu of liner incentive contracts is not much (0 to 2 %). The additional complexity in administering a menu of contracts in practical situations of sourcing is unlikely to yield significant gains over the externally set single incentive rate contract. The same is the case for repeated auditing of costs, where most gains are from one audit, as is necessary for an incentive contract. Additional intermediate audits that lead to revisions in sharing rates, etc., of incentive contracts are much lower value

(0 to 2%) and auditing expenses may outweigh benefits. The best gains appear to be from use of incentive contracts over fixed price contracts (10%), and from increasing the number of bidders (Bower 1993). With this emphasis on increasing competition, other forms of bidding competition that increase the likely numbers of bidders may become more attractive, especially multiple source selection procedures. Moreover, in sourcing with risk averse bidders the multiple source approach has many horizontal and vertical risk sharing advantages.

Interactive auctions and contracts may follow as multi-stage or sequential processes, and have benefits that accrue in the sourcing process. For instance, the ability of bidders to acquire information and allocate resources increases based on outcomes of prior sourcing in the repeated sourcing scenario. Moreover, splitting the whole sourcing into re-procurements puts les pressure on capacity per period, and changes volatility of spot markets relative to the contract. Many actual auctions are multistage in a variety of bid markets (Engelbrecht-Wiggans 1988).

The elements of the architecture encompass sourcing processes and allow resolutions of a variety of conflicts that naturally arise between supplier and customer. The approach may readily extend to the supply chain.

3.8 Sourcing and Supply Chains:

When sourcing stretches to include links to the supplier's supplier and to the customer's customer, it begins to encompass concerns of supply chain management. The supply chain becomes global when several international boundaries are crossed, sometimes several times. Logistics, taxes, quotas, language barriers, culture barriers, government restrictions, and currency issues all compound the complexity of global supply chains.

Sourcing in Global Supply Chains: Prime uncertainties in global supply chains are currency risk, resource sharing through capital financing and information for potential synergies. (i) Exchange rate fluctuations affect every multinational corporation. Global supply chains experience a similar exchange rate exposure particularly in transaction exposure, economic exposure and translation exposure. The first type of exposure is the degree to which future cash transactions are affected by exchange rate fluctuations; the second is the degree to which a firm's present value of current cash flows is affected by exchange rate fluctuations; and the third is the impact of exchange rate fluctuations on a firm's consolidated financial statements; (ii) Firms require capital to fund growth, preferably from existing sale-to-assets ratios or outside sources. However, individual members of the chain may be forced to borrow at higher interest rates for individual loans. Resource sharing within sourcing dyads may be a viable relationship contract; (iii) Access to information throughout the chain is critical for potential synergies, but sharing financial information outside the firm is too radical for many organizations. In fact, functional silos and data ownership are a struggle even within organizations.

The new B2B sourcing functionalities and strategies, often using electronic exchanges and the internet, serve to expand market reach; [15]lower prices; [16] cut the cost of the buyers' sourcing processes;[17] and identify industry best practices[18] for all participants in the supply chain. However, a strategic sourcing approach recognizes that a "central planner" can almost never design a supply chain. There is no one firm or entity that is actually making decisions for the entire chain, and that information asymmetries and uncertainties will continue to affect individual firms in the chain differently. Therefore, sourcing strategies must seek to match *risks and returns to individual firms* in the supply chain to obtain best results. Clearly, this awareness complicates the job for strategic sourcing. The auction-contracting architecture extends readily to the supply chain.

Recent studies characterize evolution of electronic markets from transaction to relationship contracts in three phases. An aggregation phase is followed by a value added services phase, and followed by an integration phase with customer processes (Ganesh, Madanmohan, Jose and Seshadri 2004).

Despite integration efforts, a strategic sourcing approach recognizes that *a "central planner" can almost never design a supply chain.* There is no one firm or entity that is actually making decisions for the entire chain, and that information asymmetries and uncertainties will continue to affect individual firms in the chain differently. Therefore, sourcing strategies must seek to match *risks and returns to individual firms* in the supply chain to obtain best results. Clearly, this awareness complicates the job for strategic sourcing theory by explicitly including conflicts in interests.

3.9 Conclusion

A constructive approach requires an architecture which would allow integrated views of the sourcing process. The architecture should not preclude conflicts of interest with a purely systemic view. The chapter describes such a rational, comprehensive architecture. It discusses evidence for rational outcomes as representative of behavior in formal sourcing processes. This increases validity of the architecture in sourcing strategy. We define in turn the seller's perspective on these processes and the buyer's perspective. The chapter introduces and defines the role of contracts and auctions and interactions between these two important mechanisms with the ability to find resolutions to the conflicts of interest in sourcing. The governance structure of sourcing relationships requires this architecture. The architecture allows replication of the process in downstream and upstream exchanges for the supply chain.

Our architecture enables a principled approach. Multiple goals and objectives that drive sourcing strategy may sometimes be conflicting, and they require policies based on sound principles. We identify these goals and objectives in the next chapter. But before that we turn to a brief introduction to the academic software included with this book.

3.10 Proxsys® Academic Version

Procurement Expert and Strategic Sourcing System or *Proxsys® Academic Version* is a set of interlinked applications to provide insights into sourcing and supply base design. The applications consist of key indexing wizards and design scenarios in the Sourcing Indexes and Exercises panels, respectively. The wizards are tools to aid computation procedures for key inputs to applications. The scenarios contain algorithms and mathematical implementations of sourcing models described in the corresponding chapter of this book. In the remainder of this chapter we introduce Proxsys® and briefly describe one of its more important wizards, the Environment Indexes wizard. In the chapters of Part 2 we will encounter each of the wizards and scenarios in turn. Exhibit 3.3 shows the starting screen.

Proxsys® assists you in designing efficient sourcing contracts if you are a buyer; and in constructing competitive tenders if you are a vendor. As a RFx tool, Proxsys® provides a platform for buyers and sellers to *jointly* analyze various contracting options, and *jointly* determine parameters that best suit their sourcing objectives. As a budgeting tool, Proxsys® allows sourcing managers and bidders alike to balance their risk-reward tradeoffs. Matching risks and rewards of sourcing improves overall efficiency, and allows sourcing to come in under budget.

As the strategic sourcing executive, you are charged with developing budgets for a variety of key sourcing contracts. Due diligence is required on short run acquisition cost as well as implications of any initiatives on long run benefits of strategic sourcing. Exhibit 3.3 presents the opening screen with two panels. The panels provide links to other screens which we describe in following chapters.

Sourcing Indexes: These include engines or wizards to calibrate the sourcing situation. Three key wizards are available to you: *Risk Profile, Environment Indexes,* and *Price-Quality Indexes.* Index values wizards are separately accessed from the *Sourcing Index* panel by clicking on the link. The three wizards help determine key indexes or input values for designs. The *Risk Profile* wizard is an exercise that helps you determine your supplier's risk attitude, which will influence the rewards it seeks from sourcing business. The *Environment Indexes* wizard helps in measuring uncertainties and decision options for design scenarios from a common environment. The *Price-Quality Indexes* wizard evaluates vendors' offerings. We describe one of these, Environment Indexes, here and leave others to later sections.

Environment Indexes: Four groups of indexes characterize Environment Indexes: The market, RFQ, selection and performance indexes. Market environment takes note of the supply and demand parameters of importance such as search costs and uncertainty. RFQ environment considers the particular sourcing. Selection environment notes the supply base parameters of relevance.

Finally, Performance environment parameterizes the costs and ranges of cost uncertainty for effort, common, and private costs. Exhibit 3.4 is the format in which the environment indexes can be captured from a variety of specific input prompts.

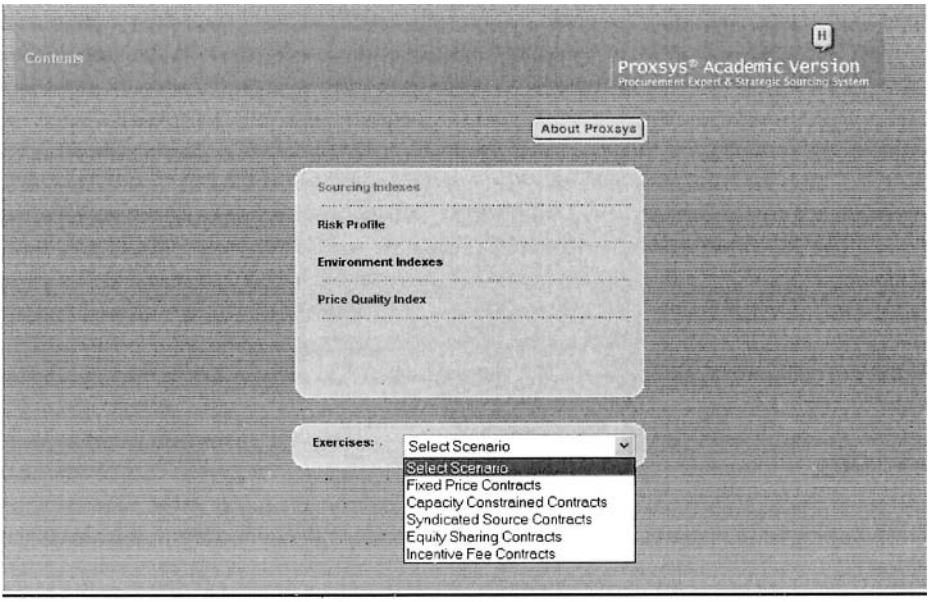


Exhibit 3.3: Proxsys® Academic Version: Contents. The opening screen provides access to modules through links and drop-down menus. Indexes and Exercises are the major panels. Online help labeled "H" provides support for all screens.

Reports: Environment Indexes provides a Scenario Index Reports for values for various scenarios. The values are based on modeling considerations that are usual in the literature. Typically, these include normal probability distributions and uniform distributions for uncertainties. However, judgment is necessary for proper characterization of the scenario index values based on the environment indexes. To access the report make your selection from the drop-down menu. The Environment Indexes wiz has the advantage of presenting a single environment that links all indexes for the five scenarios. You can calibrate the environment with key parameters for auction and contracting scenarios. You can then examine alternate decisions open to you as a sourcing manager in any given sourcing environment by examining scenarios in turn. Exhibit 3.4 is the format in which the sourcing environment index can be captured for a variety of specific input prompts.

Exercises: Design scenarios describe standard sourcing strategies. There are five scenarios in this academic version. Each scenario is separately accessed from drop-down menus from the *Exercises* panel, and fully supported with help menus.

The scenario leads to a task that the sourcing executive must complete. The set of tasks reflect increasing orders of difficulty. A task leads to a scenario that is characterized by key index values. Default index values appear in the scenario based on your answers to prompts in *Environmental Indexes.* However, you (the sourcing executive) can easily modify these as you see fit. You can view and save a top-level report summary that guides strategic sourcing based on these index values.

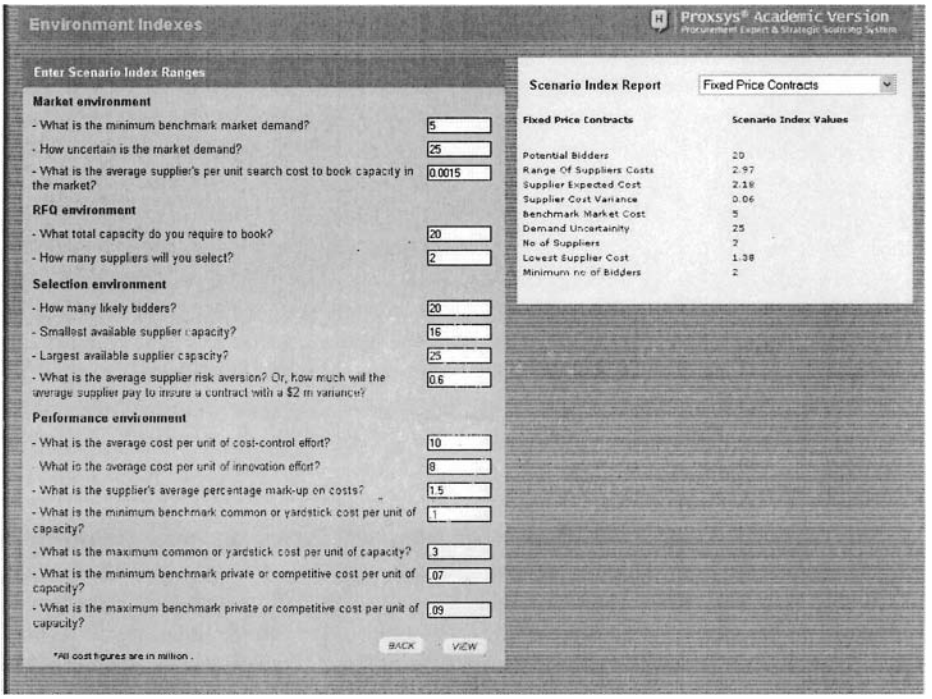


Exhibit 3.4: Environment Indexes. The four sections of prompts are parameterize the sourcing environment. You can view the scenario indexes in the report panel from the drop down menu on click of View. These index values are picked up for the initial inputs in the Exercises. You can change the numbers from the default values at will.

Naturally, you will have further questions on the sourcing scenario. For instance, what is the sensitivity of strategy to key index values? What is the impact of changing some of additional indexes? You can find answers to these questions from the Report Library accessed from the *Further Questions* button.

Each scenario has three areas in its Report Library: *Index Ranges, Index Values,* and *Reports*. A typical scenario screen is shown in Exhibit 3.5 for the Fixed Price Contract. The *Index Ranges* allows a range of sourcing environments for risk assessments and sensitivity analyses, and uses a graphical reporting format to show the sensitivity of sourcing strategy to key indexes. The *Index*

Values allow selection of particular sourcing formats and options within the range for strategic solutions, and uses a text scenario strategic editorial that reports on how to optimize sourcing. Reports are either textual or graphical.

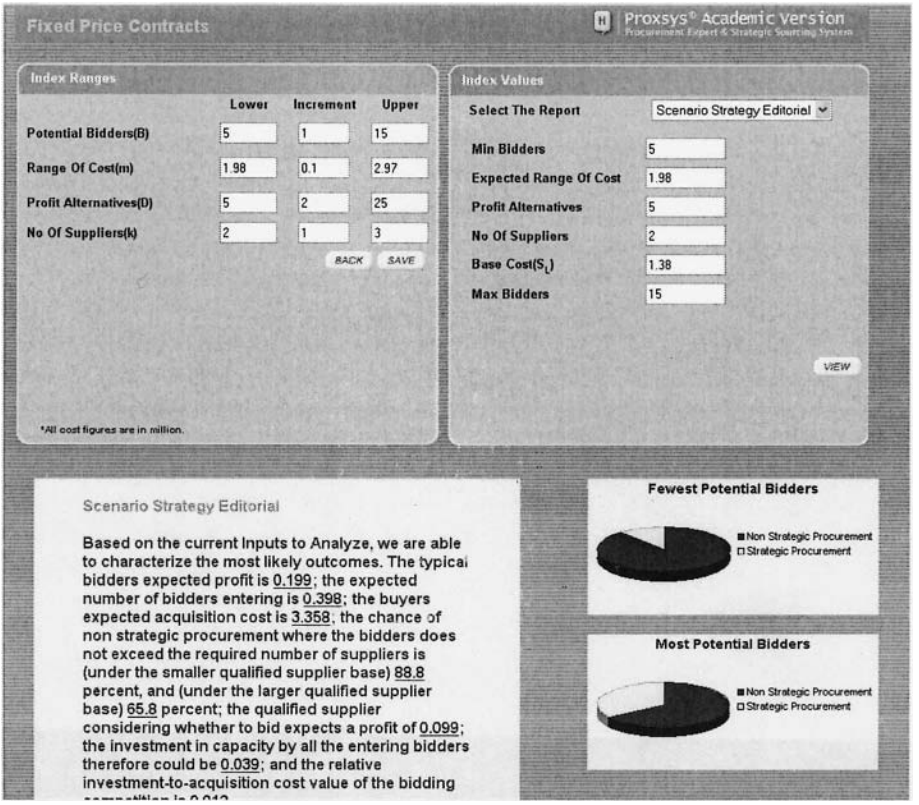


Exhibit 3.5: Fixed Price Contracts Module. The two index panels provide the scenario description. The analysis generates several reports. The strategy editorial suggests the optimal design for the award based on index values. Other reports accessed from the menu provide risk analyses for index ranges. This layout is typical of the five modules.

The scenarios assist in design of efficient sourcing contracts in different environments, and focus on a variety of tasks and alternatives. Help screens provide online explanations for all scenario elements. Drop down menus allow you to navigate options and view alternate design scenarios. Strategic solutions provide a snapshot of all parameters of interest in the efficient contract. Proxsys® allows a graphical view of how strategic solutions vary over a global range of sourcing environment indexes. Bar charts, pie charts, line graphs and tables present sensitivities of key parameters.

Five standard design scenarios are included in Proxsys® Exercises. Once you address any particular issue, using a particular scenario, you will decide whether

to combine solutions for better results. You may eventually interlink all issues and decisions for your sourcing system. A self-learning approach is appropriate to the mastery over scenarios. Menu choices facilitate selection and organization of strategic solutions and sensitivity analyses. A detailed User's Manual is included in the documentation folder of the software disk.

4: Sourcing Goals and Objectives

4.0 Introduction

Goal conflict is the material of strategy. The most basic conflict is in the competition between processes for resources. Capability to handle several business processes with a competent sourcing architecture raises the issue of how a firm should set goals and objectives of its sourcing strategy. Broad goals of sourcing are the starting point for a sourcing strategy. We discuss five major goals that provide the impetus for the firm to take specific outsourcing decisions. What sorts of measurable outcomes will help gauge a sourcing strategy's impact on business performance? The chapter untangles goals and elaborates on how sourcing goals lead to specific objectives for sourcing. These objectives are important as guides to charting a firm's sourcing strategy.

4.1 Sourcing Goals

All strategies must be geared towards some objectives, and sourcing strategies have their objectives as well. A variety of objectives underlie advantages of multiple sourcing we have discussed above. More generally, some more important sourcing strategy objectives are:

Performance Gains: Performance gains come from global sourcing; optimal timing and lot sizing; increased reliability from multiple suppliers; logistics advantages of materials sourcing; country local advantages in international sourcing;

Capacity Management: Capacity management strategies allow flexibility on opportunity costs of firm resources; better firm focus; overcome problems with "make" and internal suppliers;

Governance Flexibility: Flexibility in governance is possible through contracts and multi sourcing; challenge preconceived organizational engineered structures; use not-for-profit and other organizational entities effectively;

Acquisition Cost: Acquisition cost economies arise from compensation of variable costs rather than total cost of supplies; increased cost efficiencies from supplier driven aggregation, learning and economies of scale.

Renting Competencies: Competencies and proprietary technologies of suppliers are available for rent; involve benchmarking with industry best practices; stem from access external sources of innovation;

Many of these objectives are longer term and strategic in nature, and sourcing managers seek to identify short-run goals that would support these sourcing objectives. Buyers aim to get lower acquisition costs in the long-term, but may have to deal with a variety of tradeoffs with price discovery mechanisms in the short-term. Sellers may incur higher costs when they invest in dedicated capacity for productivity or cost controls and innovation, but they reap benefits in the long-term with increased share of business and better margins. Sourcing processes influence the industry's propensity to compete and its potential to compete in the long run, by changing dynamics of supplier entry, capacity available for contracts and investment strategies. These goals warrant deeper examination.

4.2 Performance Gains

Performance gains arise from a variety of origins. We explore some of the likely reasons outsourcing can improve performance in this section.

Global sourcing: A major source of performance gains in sourcing is the globalization it offers for the production process (Trent and Monczka 2002).[1] Global sourcing of materials saves 10 – 25 % of costs; price reduction advantages can reach up to 30 % when sourcing from emerging economies. Some usual item classifications for global sourcing are industrial, consumer, services, high-tech, basic materials and utilities. There was rapid growth of global sourcing in chemicals, machinery and equipment and components over the '70s and oil embargo years. More than half of US companies practiced international sourcing over 30 years ago, and above two-thirds have done so for over 20 years. Suppliers who support a firm's international competitors as well provide the best incentive for global sourcing – which has become almost a survival argument for international competitiveness. A strong currency in the purchaser's country is another imperative that makes imports cheaper. Purchasing ratios from international sources in US firms have increased from 9 to 25 percent in the 20 years to 2000. The integration and development of suppliers into the purchasing process is additional strategic performance gain. The majority of US firms expect to see change in integration of coordinated global sourcing with other functions in near term. In sum, gains from international sourcing include purchase price and total cost of ownership improvements; currency management; aggregation and consolidation of regional agreements; and quality, cycle times and delivery improvements.

Cost analytic and contracting skills are important and in short supply—supply chain cost drivers need to be identified and managed through the sourcing function. Communication is a key issue as cultural and bandwidth problems are unanticipated. Strategic business unit (SBU) structure is necessary in M-form firms, yet coordinated teams are required for facilities sourcing. Contracts have 30-40 attachments to master agreements with global suppliers, customized to

specific sites. In any case multiple locations for suppliers are de-facto requirements for global businesses. The suppliers could very easily have problems with specification matches and standardization even with one domestic supplier firm anyway. Supplier evaluation and selections decisions are extremely expensive and time consuming, as switching costs are often prohibitive.

Rapid Response: Reshuffling components of the value chain is necessary for performance tuning. It is necessary to have looser coupling of the value chain activities through a supply chain for rapid response to changing environment. In the life cycle of the offering, as products mature, value shifts to modular component suppliers – where the innovation is more likely taking place. This is because their markets are growing, with competitive sourcing across brands from common suppliers within a product category. The supplier's objective is to maximize performance on conformance quality; the buyer may want to maximize performance on perceived quality to its customers. Therefore, separation of quality measures through sourcing arrangements may be necessary (Fine, Vardan, Pethick, and el-Hout 2002).

Multiple attributes: Supplier selection is linked with several other program objectives. Especially in international sourcing there is a need for tradeoff analysis as price is lower, but other criteria may move in reverse; and these tradeoffs are more complicated when many foreign sources are available. Cost, delivery and quality are objectives that must be simultaneously optimized with selection of suppliers and allocation of quantity. In a multi-criteria environment there are tradeoffs between conflicting objectives, and only a few methods take these tradeoffs explicitly into account (Min1994).[2]

The relationship between lead-time and sales forecast error is relevant to source selection criteria. In Asia retailers have to give 48 weeks plus lead-time whereas in US it can be less than 12 weeks, in UK 10 weeks. Flexibility is an issue for supply. Hidden costs of purchasing abroad are chiefly long lead times, and inflexibility in order mix and volumes. Other hidden costs are irretrievable credit costs, flights and admin costs; last minute air freights; and delays at entry ports (Lowson 2001).

Supply assurance: Buyers allocate resources to sellers in order to ensure supply. Sometimes vertical resource sharing is necessary since suppliers may not have access to sufficient resources, or because it might be the buyer's policy to support small sellers. It may well be possible in some longer projects to introduce re-procurements, where subprojects are competitively bid in stages. Advantages accrue from freeing the project from capacity constraints, decreasing returns to scale, and equity issues of allowing smaller suppliers to participate (Yildirim 2003). Clearly, sustaining smaller suppliers when projects are to be sequentially bid is advantageous.

Supply assurance can be achieved by directly acquiring assets, but this may not be an appropriate approach in competitive sourcing.[3] Yet liquidity for suppliers and facilities capital employed remains a constraint on supply assurance.[4] Sourcing managers encounter problems in managing these approaches

efficiently, since the schedule of progress payments seems arbitrary and places enormous financial burden of risk on the buyer. [5] Supply assurance may also be enhanced by horizontal resource sharing between suppliers. Aggregation of supply for efficiency (ASE) is initiated by buyers as well as by sellers, since both stand to benefit from risk sharing and resource pooling that becomes possible in supplier syndicates (also see Chapter 15).

Manufacturer time is only a quarter of total lead time in made-to-order goods, and so supplier lead time is crucial; economic order quantity (EOQ) and cost minimization models subject to price and quality constraints is a linear programming approach to supplier selection. Other models are Analytic Hierarchy Process (AHP), and scoring methods. The objective is to maximize total value of purchasing, and this can best be done by integrating these approaches (Ghodsypour and O'Brien 1998 provide an integrated model). Ordering, purchasing, holding, transportation are all to be included in logistics costs. With more suppliers ordering and holding costs fall, but shipping and transportation costs could rise more rapidly; consequently, the optimal number of suppliers is very sensitive to transportation costs (Zhaohui 2001).

Quality assurance: Quality assurance has become a major sourcing objective in recent years. Widespread adoption by leading corporations of quality assurance is well known. Specific company wide programs, such as Six Sigma or the Capability Competency Model, are oriented toward infusing all firm functions with the quality assurance concept. Sourcing managers are intimately involved with quality assurance through the sourcing function. Suppliers must also partner and participate in company programs. An important related issue is one of reliability, when return of lower-grade or quality rejects is a possibility.

Reliability is key where demand satisfaction and replenishment requirements are important. A higher-grade supplier's surplus will compensate for yield loss with a lower grade supplier rejects. Under common conditions it is optimal to dual source. The intuition is that better quality products have a higher net cost, i.e., cost less salvage value. As demand is stochastic there is a positive probability of leftover unsold inventory. It is sub-optimal to keep this unsold inventory from higher net cost supplies. Therefore, a substitute lower net cost (even if lower quality) product is desirable as buffer or surplus stock, usually as unsold inventory, but sometimes used to meet peaking demand. Other solutions with a single source are of course possible when a premium price is made for special delivery to meet excess demand, or when penalty costs are easily incurred if demand is not satisfied. If a second source is used, there are additional advantages of inspection / rework being applied only to main bulk sourced items, and obtaining economies by foregoing inspection / rework on smaller second source lots (Chen, Yao and Zheng 2001).

Suppliers who do not form part of the company's quality program must provide alternate assurances though certification. As sourcing markets globalize, the number of firms competing in any program multiply. Buyers are often procuring novel products and services and have little experiential base to

accurately discriminate supplier quality. Risks tend to escalate with supply quality fraud and post purchase let down.

Researchers noted quite early that markets tend to collapse with low quality products or "lemons" when buyers are unable to distinguish quality prior to purchase (Akerlof 1970). Third-party intervention in quality certification is a likely way to circumvent the lemons problem (Leland 1979). Many marketing studies consistently find that customers form less than accurate perceptions of quality, that reference standards set perhaps by third-parties are part of quality perceptions, and that information flows or learning leading to more accurate customer perceptions will induce firms to raise overall quality provided in the market (Parasuraman, Zeithaml and Berry 1985; Tellis and Wernerfelt 1987). Interaction between reference standards and perceived quality sets the scene for systematic intervention through use of certification and quality awards (Ali and Seshadri 1993).

Why do firms develop an interest in competing for National Quality Awards? A typical set of reasons put forward by the award sites stress modern corporate management principles. A primary reason is improved market visibility a national quality award offers contestants and, of course, winners. Moreover, there are internal advantages from undertaking the self-qualification process. For instance, one international manufacturing company reports highly successful growth between the two [Malcolm Baldridge National Quality Awards (USA)] wins, first in 1991 and, after the mandatory waiting period, again in 1996. Companies that have already achieved quality levels prescribed by certification such as ISO 9000 and 14000 are given a higher motivation to improve, provided by competition for a National Award. With all these virtues it is not surprising, therefore, that there has been a trend worldwide to institute and contest in quality certification and awards.

The worldwide quality certification movement for certification gathered momentum in the eighties. European standards, North American standards, and Asian standards emerged soon after in order to allow cross-border supplier agreements for manufacturing and selected service industries. Global suppliers to companies in these markets were under pressure to be certified. Industry associations increased their involvements and scaled up various dimensions of quality certification as a business proposition. This included awareness building, documentation, implementation training, and both internal and external auditor training.

Global quality certification standards vary greatly due to their international origins. They also varied in application of audit procedures. While buyers understood certification when accredited by their own country certification bodies, they poorly understand certification presented from other countries, and inter-comparability is a problem. There is buyer pressure to develop a comprehensive governance structure both for cross certification comparisons, as well as cross-functional comprehensive quality certification. Quality certification

comparisons across borders indirectly also improve qualified capacity in the supplier base, another key goal of sourcing.

4.3 Capacity Management:

Capacity dedicated to sourcing business is critical in long-term price controls as well as in decreasing risks of stock outs. A usual ongoing objective is to insure the buyer against sudden surges in demand. This insurance will come at the expense of a short-term increase in acquisition cost per sourcing. Expected penalties for stock out in the supply base, or costs of insurance against stock out, can be compared against acquisition cost increases. This gives a justification for excess capacity to contract based on strategic long-term considerations in sourcing.

Opportunity cost of capacity: Often competing sellers will need to make investments in cost reduction, production capacity, or even in the innovation process in order to qualify as a potential supplier. This investment is irretrievable once the decision to participate is made. In deciding to make a capital investment the seller must judge how much it should spend in order to tool-up its existing facilities for the sourcing contract. Manufacturing continues to account for 70-80% of assets in industrial organizations. In manufacturing processes, key to creating competitive advantage is to devise proprietary processes and technologies, and not merely to access resources and to meet performance standards. This realization leads naturally to the activity of outsourcing in order to allow focus where proprietary advantages exist in those activities not outsourced.

More efficient use of resources by some suppliers, allows an overall freeing up of resources for their most efficient uses. There is logic in search for efficient resource utilization, and minimization of opportunity cost of resources. For instance, product development capacity can be outsourced. Decision making on what aspects of design and engineering should be outsourced involves the sourcing function. The role of early supplier involvement (ESI) in this stage is well known. In the life cycle, process innovation receives more attention than product innovation, and is testimony to the role of manufacturing over design; actually the importance oscillates. Due to long lead times in excess of a year on engineered-to-order as is the norm, performance gains from outsourcing are difficult to allocate. However, outsourcing orders grew 150 % according to one study (Dekkers 2002). Capacity smoothing for a planning horizon of say two years is easier with outsourced capacity, followed by capability enhancements.

The implication for outsourcing differs when development of product designs is required or when routine demand-satisfaction is required. Re-mapping of processes in new product development leads to outsourcing of selected stages in product manufacture. Staged methodologies may require outsourcing of manufacturing aspects in order to progress quicker through specific later stages, for an overall shorter time to market. Technology scans reveal the base, key and

pacing technologies relevant to the business. It is counterproductive to own all resources and factors of production due to opportunity costs of resource ownership. It makes sense to outsource these requirements, while viewing technology a recombinant structure. In some cases lead time for vision systems exceeded five years for specific new orders in product development and introduction. Impact of design changes on manufacturing capacity and lead time is critical, and is the impetus behind concurrent engineering. Clearly, there is a trade-off between technical performance and manufacturing lead-time, especially in outsourcing. In practice, there is a delay in execution of orders, up to 30 percent over estimates on actual delivery lead times. Therefore, there is need for identification of non-critical activities, immaterial improvements, and inconsequential efforts, which consume effort and resources and divert attention. Mature technology components add little value to perceived quality of product.

If a firm outsources difficult tasks and insources easier ones, it will loose its competitive advantage. The recommendation is to identify proprietary components, and to separate knowledge of architecture in a subsystem from actual manufacture of the subsystem; and to retain the former – or outsource only procurement. This proprietary and valuable knowledge is what links customer perceptions of performance to systems that are critical to performance. Supply base considerations drive the decision on what strategic / non-strategic parts are critical to performance quality (Venkatesan 1992).

Strategic Core for Make or Buy Decisions: Market incentives operate in the buy choice versus investment incentives in the make choice. The role of contracts in these incentives is explicit, and serves to link the core structure within the firm to the supply base.

Internal suppliers can also be put through certification criteria and compared with external suppliers. One survey found internal suppliers "not better" than external suppliers in 80 percent of cases. Preferences on lead time, bid price, and quality is often given to internal suppliers. Why? Preference is due to overhead absorption, capacity utilization and loyalty. Possibly historical union contracts also lock in work. Total quality management (TQM) and just-in-time (JIT) considerations arising from Deming's work suggest limiting the number of suppliers to reduce statistical variance in supplies, and get operational gains. Loyalty and long-term relations are sought using fewer suppliers. Buyers can organize suppliers into modular groupings with tiers, based on which set of suppliers bids competitively against internal suppliers. Another reason for using external suppliers is to reduce organized labor costs.

One survey showed the preference for 2 or 3 suppliers, for a majority of respondents. However, current practice had 4 or more in almost 40 percent of cases, and single suppliers in 12 percent of the cases. The fraction that preferred single suppliers was 17 percent. Therefore, multi-sourcing was actually used in 88 percent of instances and preferred in 83 percent. Among the most important measures for self protection in sourcing is market monitoring, and multi-sourcing. Contractual safeguards with single sourcing appear to be inadequate. The survey

showed that there appear to be two types of suppliers. One type is very long-term, and the other will last from 3-5 years. The proportions are about 75 % and 11 % respectively. However, long-term relations as well as short-term ones with both groups are governed by short-term contracts (Park, Reddy, Sarkar 2000).

Conversion: At the end of peek periods of demand, during downturns or recessions, and during sustained overcapacity phases, the buyer often seeks to have suppliers seek business in other industries. This might assist in mitigating the bankruptcy or dissolution attrition rate of suppliers from lack of sourcing business. It may also help defray overhead costs (Gansler 1995; Rogerson 1992).[6] Operations and Maintenance (O&M), R&D, and DOD payroll are the main categories of expense. Some evidence exists for the argument that generalized sourcing could serve as a way of regulating unemployment in organized labor.[7] These advantages seem to coincide with another goal in sourcing, that of governance.

4.4 Governance Flexibility:

Organizational activities require governance structures, and sourcing strategy affords a variety of governance options. Some competitive advantages derive from the ability to choose a governance structure that may be absent if the activity is internal to the firm.

Financial market governance: Some suppliers have a stake in financial market valuations, and advantages of this form of governance may be useful for a sourcing strategy. An argument can be made that information and incentive constraints inherent in the innovation process require that buyers need to create "prizes" for innovations by sellers. A stock market blip often accompanies announcements of the firm's winning bid (Rogerson 1988). [8] The most natural method for awarding prizes is to allow sellers to earn positive economic profit on production contracts, and the market interprets this correctly. The seller expects an economic profit equal to the initial winning profit's excess over any opportunity costs. On the other hand, when the buyer (usually a government agency) declares detection of fraud or misdemeanors in the sourcing process with certain suppliers it selectively leads to stock market dips in valuation of the supplier. The government clearly interprets this as a deserved penalty to the supplier (Karpoff, Lee and Vendrzyk 1999).[9]

Capital structure: The supply chain's impact on capital structure is difficult to assess. There is a role for suppliers in the level of debt financing by firms. Capacity expansion is perceived by suppliers as a credible commitment by buyers not to behave opportunistically; so is debt in capital structure. However, there is still the possibility that after entry there may be incentives for the buyer to opportunistically buy at variable cost and not pay full or total cost to suppliers who entered. Suppliers may have to go along rather than lose their investment entirely. Increase in output over profit maximizing levels when demand is

uncertain is an indicator of riskier firm behavior. Higher debt (lower shareholder liability) leads to adverse incentives, and riskier behavior of this type. But higher output enhances supplier entry and decreases sourcing costs. With this endogenous view of supplier entry, all rival downstream firms get lowered input prices. The firm's increased output advantages translating to lower costs with its own suppliers is spread even to its rivals in the oligopoly market, reducing everyone's sourcing costs. Yet leverage costs are individually borne; and revenue and profits move in opposite directions for the leveraged firm (Krishnaswami and Subramaniam 2000).

Information and governance: Single sourcing is regarded as a specialized option for the small weak purchasing department. Multiple sourcing yields yardstick information, where suppliers' performance measures can be compared with each other for relative compensation; and multiple points of view for information on technology. However, the polarization into "single-multiple" may be unnecessary, as conditions will determine when particular numbers of suppliers are strategic or optimal.

Single sourcing leads to investment in capacity and willingness to adapt to requirements of the buyer in irreversible ways. Long-term contracts help to increase purchasing power, and reduce price escalations. There appears to be strong information acquisition based reasons to recommend multiple sourcing with short-term contracts as a governance mode (Ramsay and Wilson 1990). Selection of multiple suppliers serves long-term objectives, such as to prevent departures from the pool of qualifying of interested suppliers from which bidders are attracted. In longer-term sourcing, multiple suppliers do not have to deliver simultaneously but can take turns in subsequent periods. There is an immense value to competition in sourcing (Bower 1993).[10] One US company has six worldwide suppliers providing similar supplies.

The buyer needs information on costs that often are available only with experienced suppliers if at all. The sourcing process is often handicapped with uncertain cost estimates that a long drawn process of contracting alone will reveal (Reichelstein 1992).[11] The use of cost-adjustments or division of sourcing into a planning phase prior to execution is indicative of this need (Lewis and Sappington 1997).[12] Product development or prototype development is an important planning phase that preceded sourcing of units themselves in much of government sourcing.

Social welfare: Governments buy for reasons of the public good, and on behalf of the public. Therefore maximizing social welfare is a prime objective. The seller will make that level of investment that exhausts economic profit, so in the long run there is no incentive for other non-strategic sellers to become interested in such business, leading to a decrease in welfare. Economic profit is higher for more sellers under multiple sourcing. So is welfare through increasing over the long-term available seller investment capital in sourcing business in the public interest. This could be a win-win proposition as investments could help further another key sourcing goal, that of cost management.

4.5 Acquisition cost

A chief buyer concern is efficiency of the sourcing mechanism in terms of acquisition cost. The buyer may use several strategies to reduce its acquisition cost. For instance, judiciously increasing the number of qualified bidders increases the potential to compete and reducing selection risk and capacity utilization increases the propensity to compete. The buyer may also use performance risk management approaches with contractual mechanisms, such as incentive contracts. This strategy is calculated to reduce the seller's indulgence in bid padding to cover risk premiums, while providing incentives for cost controls.

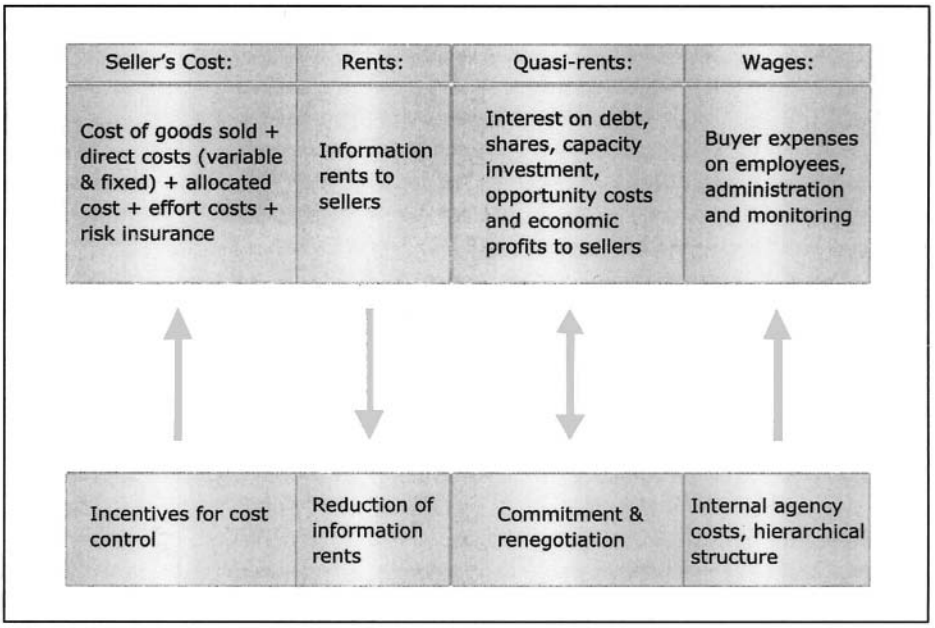


Exhibit 4.1: Tradeoffs in component economic quantities in acquisition. Indicated is the tradeoff due to conflicting pressures of providing incentives for cost control and reducing information rents; time-consistency issues of commitment and renegotiation; and internal agency costs that affect organization of the sourcing process.

When there are so many pricing schemes possible, which one is best for the buyer? Some possibilities for pricing are reverse auctions, priority pricing schedules and, of course, fixed price (linear or non linear) approaches (Harris and Townsend 1981).[13] Dynamics of entry, capacity and investment have implications for the buyers expected acquisition costs. Expected buyer acquisition cost is dependent upon competitive pressures of auctions that influence information rents; on incentives for cost controls; on innovation that may arise from incentives to suppliers; on wages the buyer must pay for administration,

supervision and monitoring; to name just a few depicted in Exhibit 4.1. Clearly, acquisition costs itself has many economic components.

Pre-and-Post-Award phases: Equally important is to manage the trajectory of expected acquisition costs in major programs over post award phases. The tendency toward creating an effective monopoly from use of winner-take-all awards has been noted earlier. This tendency is a serious problem for buyers since annual renegotiations of sourcing contracts could lead to acquisition costs that continue to rise sharply as competition decreases. Splitting the award is expected to counteract this tendency by increasing the potential to compete in the post award periods, and by preventing departures from the pool of qualified and strategically active sellers.

There appears to be an empirical regularity of price escalation in post-award phases. The main reason is that design adaptations become necessary in complex projects and renegotiation in a non-competitive situation is unavoidable. The implications for contract type, whether fixed price, or cost plus, are several when buyers factor in costs of renegotiation and the process of design adaptation frictions. Often the buyer is a government that has changed its budget allocations or priorities due to mid-contract elections (Estache and Quesada 2001). While there are a variety of reasons for this, it might appear that the monopoly situation created by a clear design winner during the immediately pre-award period leads to upward pressure on price. Would dual sourcing help? Any price reduction benefits expected from the potential for post-award competition from multi-sourcing must account for rational behavior that may cause the seller to anticipate later stages, and adjust their pre-award prices. Price increases in the pre-award period may mitigate price decreases expected from post award periods. Empirical studies on acquisition cost dynamics in sole, single and dual source sourcing have dealt chiefly with defense sourcing.

Learning curves: The trajectory of acquisition cost in repeated purchase procurements follows the well known "learning curve" or "experience curve." In its more popular form, the learning curve relates marginal cost of production, or average per unit cost, to cumulative production achieved by the firm. Measures of cumulative production could be number of units or labor hours expended. Several studies show that the learning curve follows an exponential decrease in cost with cumulative production, with a constant learning rate. The "learning rate" is the decrease in cost for a doubling in cumulative production experience. Most often this rate lies between 50 percent and 100 percent implying that unit cost reduces to this fraction of initial cost on doubling of cumulative production (Dobler, Burt and Lee 1990). The learning rate may interact with level of output, and larger firms may have a more rapid decline in costs from learning.

A rationale for existence of an exponential form learning curve is that production managers find specific opportunities for direct labor cost reductions as they increase their experience. However, these opportunities become increasingly scarce as experience grows and existing opportunities are exhausted. There exists a saturation level or floor, which might be some ideal benchmark cost below

which production managers cannot reduce cost despite further experience. The trajectory of acquisition cost in post-production periods should therefore follow an exponential reduction to this ideal industry benchmark.

Sourcing managers factor in the learning curve for suppliers in their negotiating strategies. They require incumbent suppliers to quote re-procurement prices that correspond to learning curves that their research determines with specific quantitative estimation methods. Re-bidding of programs in sequential sourcing allows the buyer to take advantage of learning curves in a competitive setting.

A rationale for equal production splits in multi-sourcing with learning specificity is that sourcing not bestow unequal advantages to suppliers. If the buyer uses an unequal production split, the supplier with the larger production award would likely have lower marginal costs at the time of re-bidding. This expectation of unequal marginal costs would then lead to non-competitive behavior by the disadvantaged bidder (Lee 2000). Sourcing mangers are concerned about maintaining an expectation of cost competitiveness in their supply base.

Initial parallel sourcing that leads into single sourcing may provide incentives for sellers to invest in quality improvements while learning in a sequential fashion. The buyer parallel sources for a predetermined number of time periods and then awards the entire supply contract to the best single source. This hybrid sourcing form is better than awarding the entire contract to a single source at the start (Deng and Elmaghraby 2002).[14] Moreover, it allows additional degrees of freedom with competencies available to the company.

4.6 Renting Competencies:

A major advantage of outsourcing is its technological dividend. Specialization of its suppliers in differentiated areas of competence yields competitive advantages to the buyer. Suppliers are able to focus on future technologies, learn from many clients, and reap benefits of scale from aggregating supply to multiple clients. For all these reasons, buyers look to suppliers for innovations in materials, components, subassemblies and equipment.

Incentives for technology sourcing: Suppliers can often invest in capital equipment and tooling that significantly reduces direct labor hours necessary for products. Direct cost is the key determinant of several markups and overhead allocations. A small saving in direct cost will lead to savings in sourcing costs of several multiples. Direct labor costs savings through appropriate investments in cost control are far more important in the sum than a few percentage point reductions feasible in supplier profit margins.

Innovation and investment by suppliers is a major concern, therefore, of sourcing. The need to provide right incentives to suppliers in order to accomplish this is a well-recognized problem. Costs of investment and innovation are

privately borne by suppliers and cannot be observed or directly compensated. Moreover, competitive risks of non-selection in bidding adds to the disincentive for innovation and investment, though resulting efficiencies might improve probabilities of selection. Suppliers must achieve a risk-return balance with innovation and investment in cost controls.[15]

Organizational forms for technology sourcing: Technology can be externally accessed with many organizational forms, such as alliances, Joint ventures, licensing, acquisitions and of course sourcing and supplier relationships. Constraints that determine organization of the research outsourcing function are: impact on the firm; time horizon; control over activities; control over results; start up time and costs; reversibility, and contract forms. The interactions between organization form and constraints help explain various approaches to outsourcing of technology (Chiesa, Manzini, Tecilla 2000).

For capital projects, leveraging the contractor's competencies makes most sense. Up to 62 percent of planning, sourcing, and design activities are outsourced by owners of capital facilities. Continuum of work structures, with shifting inter-organizational boundaries, may be discernable. The continuum is of owner performance, leadership, and involvement; and a symmetric but reverse structure for the contractor. The boundary is demarcated in this continuum through distinction of functions and capabilities. A basic issue is of operationalizing core work and responsibility for owner and contractor. The criterion for separating this between owner and contractor is optimal use of resources. Many cases subjective judgements are measured with, and then used in some form of optimisation model. It is important to note the degree of sensitivity of the boundary demarcation to the scaled measurement process (Anderson, Patil and Sullivan 2001).[16]

Specification management: It is strategically important for suppliers to be closely involved with any specification development or modification in the buyer's RFQ. This is obvious for modified rebuys, or new buys; but even straight rebuys offer potential for re-specification. Convincing buyers that specifications should be revised allows potential competitors to dislodge incumbent suppliers and is a common practice in sourcing. Sourcing managers are interested in quality enhancing and process cost reducing improvements in procured items.

Compression of technological cycles, to sometimes as low as six months or less, offers scope for continual product improvement. Product policy in sourcing includes obsolescence planning and depreciation of capital goods. Changing regulations and customer expectations provide necessary pressure for more demanding specifications. Careful planning by equipment and component suppliers is necessary for financial lock step in the sourcing cycle. For instance, depreciation of computer systems hardware equipment by users should not be out of sync with productivity gains from next generation releases; nor should computing capabilities outstrip operating systems features planned for release. The popular Moore's Law is a way of coordinating the entire technological cycle

from component suppliers through value added resellers to systems sourcing managers.[17]

Productivity: Sourcing processes can influence productivity of the supplier base. In industrial sourcing suppliers may substitute capital equipment for some forms of labor, for productivity gains. However, there may be disincentives to do this in certain awards that allow for allocated costs reimbursements in dual business supplier bases (Rogerson 1992).

The impact of sourcing incentives on primary production is of particular concern in economies where a large portion of the population has livelihoods depending on agriculture. In emerging economies sourcing of agricultural output is often done by governments. Governments use administered prices for output quotas. Marginal output in excess of quotas can be sold in regulated or unregulated markets at market clearing prices. The producer's payoff derives from components such as output quotas, taxes, welfare provisions, investment provisions, wages, and shares of marginal output in excess of quota that could be sold. In Chinese agricultural sourcing, institutional arrangements and incentives associated with payoffs from marginal output retained by producers had changed from communal systems to responsibility systems, with major impact on productivity in agriculture (McMillan, Whalley and Zhu 1989).[18]

4.7 Conclusion

The multiple goals for sourcing may sometimes be in conflict. The chapter identifies objectives deriving from goals such as performance gains, capacity management, governance flexibility, acquisition cost, and renting competencies. The buyer should prioritize these objectives for its strategic planning. For instance, particular priorities in Part 2 of this book are capacity management tradeoffs with acquisition cost; or innovation and governance tradeoffs.

The priorities in government sourcing are often governance flexibility and renting competencies in the public interest. Innovation design and development accompany many systems bought by government agencies. Additional objectives that come under scrutiny are controls on acquisition cost when spending of public monies and capacity management for surges in requirements. The next chapter examines this important area of sourcing.

5: The Government Sourcing Environment

5.0 Introduction

Societies consume public goods and services such as public health, education, infrastructure and defense. Many periodic evaluations made of government buying find processes less than satisfactory. For instance, Fishner (1989) describes waste, destruction and deterioration. Effective renting of supplier competencies is clearly the dominant priority when sourcing in the public interest. Some of these buying processes are very long term and of immense scope. Acquisition cost and flexible governance are other prime objectives. Governance goals have special developmental objectives. Strategy demands capacity development where a supply base may not even exist. Production and delivery of public goods and services occurs all across the economy, and a wide variety of organizations participate. But who actually is the "buyer" that uses public money to buy? It is natural that budgeting processes with tax monies will involve special concerns for acquisition cost management. What experiences drive concerns of public agencies entrusted with the sourcing task? This chapter examines buyer's remorse, perceptions of governmental policies, and conflicts between objectives inherent to sourcing strategy in the public interest.

5.1 Government Sourcing and Buyer's Remorse

The accepted principles for public procurements are: transparency, integrity, competitive supply, effectiveness, efficiency, fair dealing, responsiveness, informed decision-making, consistency, legality, integration, and accountability.[1] To achieve these, an activist approach from government executives to procurement and contract management is necessary. The problem of buyer's remorse arises when sourcing decisions lead to problems that could have been avoided. The risk management framework for buyer's remorse includes anticipation of:

- litigation by disappointed suppliers on breach of directives
- fraud, theft and waste
- bad publicity
- adverse effects of social exclusion on political stability

- missed opportunities for other desirable socio-economic outcomes

Some public executives in newly industrializing countries (NICs) put the burden of buyer's remorse very starkly. "Government works on the assumption that "everyone is a thief!" Therefore, the safest strategy for the honorable buyer is not to spend any money from budgets. Political lobbyists of opposing camps see to it that there is bad press and subsequent harassment of officials if the award does not go in their favor. The dubious honor of the most honest government agency goes to the one that does nothing, buys nothing and returns its budget."

No country in the world appears to have escaped improper, corrupt and wasteful practices in public procurement. Corruption as defined by the World Bank is abuse of public office for private gain. The undue influence of corruption has legal, administrative and economic costs. But corruption is only one source of buyer's remorse. Other sources are identified continually as this is a moving target. When a competitor uses other means to minimize market pressures, pricing or quality or performance of the project is diminished. Need for reform is widely recognized and many agencies have taken sterling initiatives to deal with buyer's remorse. Increasingly, administrative levels for such initiatives have risen from the public corporation, to the national ministry or department, to the office of the national chief executive, to international trade bodies. E-commerce and e-Governance are promising ways to address buyer's remorse.

5.2 Governance and Development: Electronic Commerce

The regulatory and industrial policy frameworks under which businesses operate have an abiding influence on their perceptions of electronic commerce (EC). With increasing membership of the World Trade Organization (WTO), volume and scope of cross-border trade is dramatically increasing. Some estimates put EC at 5 percent of inter firm and retail transactions; already touching magnitudes in several trillions of dollars in some regions; and over a hundred trillion dollars across borders. Improving inventory practices and releasing wealth locked up in inventories can contribute several percentage points to GDP growth. Investigation into uses of EC in purchasing and marketing reveals possible areas where government policy could impact user perceptions of EC.

1. Perceptions of the legal system are important and have bearing on use of EC. Moreover, more upstream the business, higher the likelihood of web exchanges. Improvements in the legal system and transaction cost reduction should be aimed at OEMs and manufacturing.
2. Perceptions on taxes conducive to EC are a key influence on perceptions of legal systems. Ability of the legal system to provide third party authentication is important. Legal jurisdiction becomes a problem when physical and virtual locations do not match.

3. Industrial taxes and transportation are closely linked; and ports and customs duties add to costs. Streamlining tariffs and logistics charges have a big role in favorable perceptions of industrial taxes, and could encourage web sourcing. Paper permits and documentation needed for trans-shipment across toll zones are major hurdles for rapid cross jurisdiction transport.

4. As there are network externalities in adopting web exchanges policy should use tax incentives and write-offs for early adoption. The cutting edge of practice is also often the bleeding edge. With agencies taking e-governance initiatives in sourcing there would be a big lead user effect that benefits the entire network.

EC and web exchanges are important new mediums of transacting across borders, and bring access to small and medium enterprises (SMEs). Perceptions of SMEs are of particular importance to government as they account for very high percentages of employment in local economies. What other perceptions by SMEs affect their adoption rates of EC? Evidence exists that adoption rates are positively related to perceptions of relative advantage of EC; its compatibility; its security / confidentiality; and its observability. With the growth of EC and role of governance in its spread has come an awareness of e-Governance, and specific government interest in outsourcing. The government relies heavily if not exclusively on others to provision public goods and services.

5.3 Renting Competencies and Capacity

By one estimate, governments spend over 10 percent of national income procuring goods and services in the public interest or national defense. Whether in developed economies or emerging ones, Government sourcing programs the world over are large and growing, and cover a variety of sectors. As the world's largest buyer, US federal procurement has several major domains, such as Interior and Defense, where government departments procure public goods and services. An apex body that governs federal processes is the Office of Management and Budget, but each state has its own independent sourcing agencies. In the health care sector, a US federal Government program, Medicaid, is a buyer that pays for care at over 400 supplier hospitals in California; other states, however, administer their Medicaid sourcing process independently. The largest federal sector is military procurement, where the US Department of Defense (DOD) spends more than 1.4 percent of the US GNP. Contractors with DOD often have to make large investments in capacity and R&D. A recent estimate is that DOD has 53,000 sourcing personnel, with 27,000 officers dealing with 170,000 suppliers (Gansler 1995; quoted in Karpoff, Lee and Vendrzyk 1999).

Capacity Utilization: Typically prices of fairly standard goods and services in competitive markets are determined by competitive forces and spot markets. However, in government sourcing goods and services are often sourced independently of spot markets and based on built-to-order contracts that have a significant cost reimbursement component. Accounting costs of such

procurements are subject to incentive behavior when the source produces items for both commercial markets and government markets. On average major contractors have an approximately 80-20 split of Government and commercial business.[2] Overhead costs are pooled and then allocated across products, usually in proportion to the amount of direct labor expense on products. This creates a vehicle for allocation of fixed costs. There is therefore an incentive to incur more direct labor on government sourcing and then to allocate more accounting costs to the sourcing program. Studies indicated the cost type breakdown assessed on average from four major prime contractors in aerospace was (Fishner 1989): Direct Labor (20 %); direct materials (52%); Overhead (28%); G&A (8%); and M&E (20%). While all these costs are actually incurred by the firm, wasteful expense leads to a higher profit than otherwise in government sourcing. Magnitude of this incentive is extremely large, with huge incentives to substitute labor for capital equipment, or materials as well. Dual sourcing with share-of-business awards causes these incentives to drop and is an argument in its favor; but a reallocation that raises incentives again may occur if other non dual sourced contracts exist with the same supplier (see Chapter 18 for such awards). The implication for subcontracting is that the firm will keep too much of its government work in house, and too much of its commercial work will be outsourced (Rogerson 1992).

Governments often engage both in competitive bidding, and in sole sourcing with a profit policy. The two may well be related in some procurements. Acquisition cost is highly dependent on capacity utilization, as illustrated in Exhibit 5.1. For lower capacity utilization (CU) rates, acquisition cost would depend on whether single or dual sourcing was employed. However, industry capacity utilization in excess of 80 percent made single sourcing ineffective. In their analysis of data on risk and return from aerospace industry, Greer and Liao (1986) developed a multiplicative regression model specification. They estimated this model on data from 87 annual buys of weapon systems. Exhibit 5.1 reproduces the essential conclusion schematically.

Creating Capacity: Clearly, when capacity utilization rates are high, multi-sourcing would serve competitive purposes as it increases dedicated capacity and simultaneously reduces capacity demanded from a given supplier (See §14.4 for a scenario with price-capacity curves). All these considerations highlight primacy of capacity creation and competition enhancement goals in government sourcing. Buying agencies adopt a variety of activist strategies to fulfill these goals. Among these are (a) flow of information to the supply base; (b) increase the number of government customers to encourage demand; (c) increase the number of sources through openness to international supply bases, grouping requirements to avoid narrow specifications, streamline source selection procedures; (d) widen rather than deepen tiers of subcontracting by assuming integration responsibility; and (e) maintain two sources through either dual sourcing or second sourcing (from defense acquisition studies).[3]

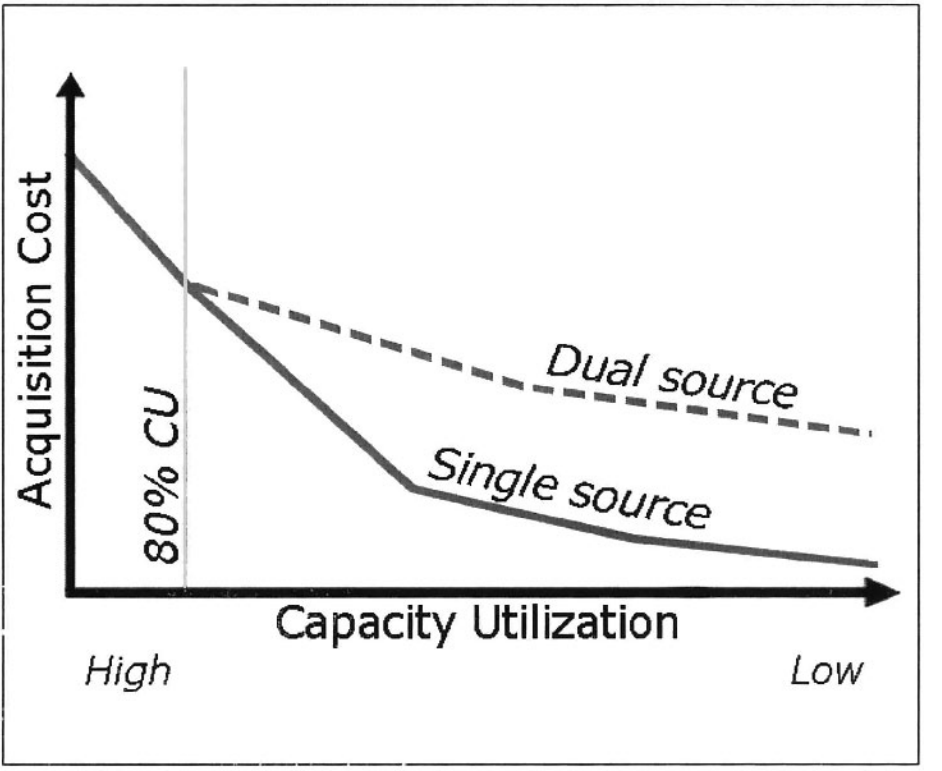


Exhibit 5.1: Sourcing awards and capacity utilization. Acquisition cost is log-proportional to capacity utilization, and introduction of competition is effective only for higher CU rates. *Source: Adapted from W.R. Greer and S.S. Laio (1986).*

Creating capacity can lead to cost reductions. Product break out has led to savings of 78 percent. Government identifies a subcontracted product in a prime contract, takes responsibility for furnishing it and integrating it with the prime contract. It therefore directly takes bidding competition to second tier contractors. Less demanding on the buyer but delivering similar savings is the technique of form, fit and function (F3) specification. This releases contractors from unnecessary constraints on design by focusing on interoperability and performance. The F3 approach is particularly favorable to renting particular supplier competencies as it frees the supplier to work with its competitive design and production advantages, rather than conforming to a general pattern. Successful use of F3 has led to 79 percent cuts in unit cost, and savings of $2.3 million on a single designed item. These examples of significant success encourage a strong government interest in goals of competency, capacity and cost reduction through competition enhancement strategies. Governance therefore has indirect as well as more direct impact on acquisition costs.

5.4 Governance and Acquisition Cost

Contract pricing could be based on several approaches, the simplest of which is a fixed price. Besides being simple, it has the advantage of forcing suppliers to get all their profit from price-cost margins, and so provides strong incentives for cost controls. However, cost plus contract pricing is commonly used when buyers are very uncertain about legitimate estimates of costs. These require a policy on profit, added to audited cost reimbursement. Increasingly, profit policy is an incentive fee, such as a percentage of cost over-run or under-run that will be borne by the supplier. A US General Accounting Office survey put the cost-share for many government procurements at between 15 and 25 percent, with an extreme of 50 percent. Misestimates by the government of the target cost could potentially lead to severe over-runs in which case a price ceiling would be required (the fixed price incentive contract, as termed by GAO); or could lead to undeserved supplier profits from major cost under-runs. Due to difficulties with the government's estimate of costs, it is often preferable to have the supplier itself state its budget or target cost, and base audited cost over-and under-run on the supplier budgeted or bid target cost. This leads naturally to a self-selection of the supplier into one of a menu of contracts, or a competitive bidding process for contracts. Reichelstein (1992) discusses an application in the German DoD.

Post award renegotiations: Cost estimates for major systems procurements have a tendency to hold stable during design and budgeting phases, and then rise dramatically. The four year price behavior prior, during, and post award of the contract, is depicted in Exhibit 5.2 (Gates and Miller 1985).

Competitively bid contracts may be priced to yield renegotiations rooted quasi rents to contractors in defense buying – and there is almost continual renegotiation of pricing, resulting in situations similar to sole- sourcing. It is in order to administer prices in this situation of renegotiation that many norms have been developed under Federal Acquisition Regulations to govern awards.

Profit policies are usually in place. Overall profit rates measured by mean annual operation return on assets in contractor firms is around 14 – 16% (Karpoff, Lee and Vendrzyk 1999). Yet, many firms suffer from various degrees of penalization due to possibility of fraud investigation subsequent to audits. Clearly there may be miscalculations, sometimes deliberate, on both sides regarding optimality of the contract awarded. Competitive bidding prior to contracts that may be renegotiated due to discretionary learning helps to ameliorate the problem, and DOD procurements often follow this pattern. Sole sourcing may be used initially to encourage R&D investment and recovery. In production phases, sole sourcing gives rise to quality problems, and is often replaced by dual sourcing. This is despite sole source contract price decline over time.

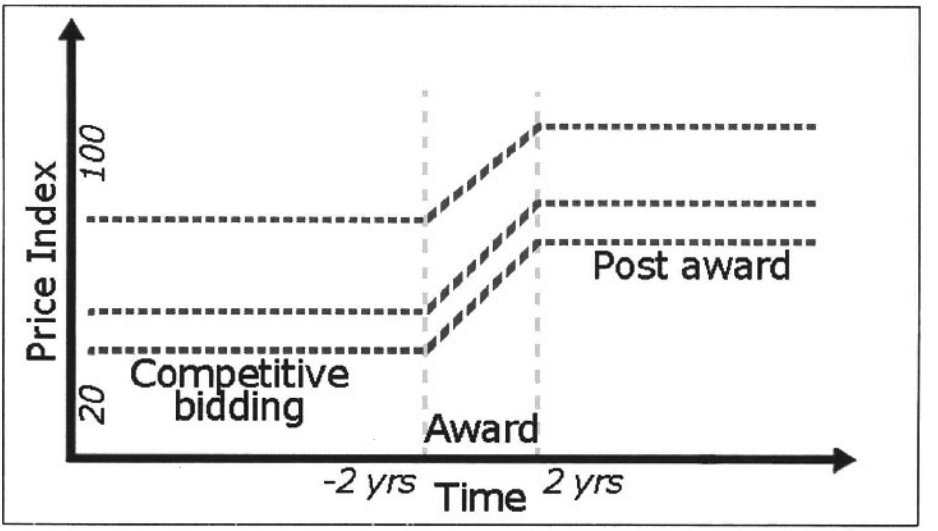


Exhibit 5.2: Pre-and Post-Award price. Cost estimates as a percentage of latest estimate – versus - years from contact award date. *Source: Adapted from W. Gates and J.L. Miller (1985).*

Government supported programs such as Medicaid contracts also show a trend toward competitive bidding by hospitals and clinical laboratories. Annual costs of medical programs in the US exceeds 100 billion dollars, and spend management is naturally a major concern. Fee schedules for specific services in most such programs show rapid inflation, and the industry has lobbied massively against competitive procedures on grounds that quality would deteriorate and service centers denied government business, often 30 percent or more of their income, will go bankrupt and disappear. Health policy think tanks have suggested multiple winning bidder competitions as a possible solution. Physicians could shift business between multiple winning clinical laboratories based on their bid prices and quality acceptability.[4]

Award types: Multiple winning bids allow buyers to split the award. However, split awards introduce the possibility of strategic coordination where a supplier may bid very high except for the share of business it wants. Such implicit collusion between suppliers in the split award is likely to make it unattractive to buyers. However, coordination requires a good understanding of competitors' costs to lead to implicit collusion and in situations of innovation procurement this knowledge may not be available (Anton andYao 1987).

What are conditions under which dual sourcing can reduce post award cost increases? What pre-and-post-award combination reduces costs the most? When competition and completeness are substitutes, a switch to winner-take-all auction after the initial use of dual-source will reduce overall costs. The intuition is that the pre-award phase with dual source has two advantages. The learning curve is steeper under dual source awards, as found by empirical studies. Moreover, a

scale effect under dual source reduces information rents as the award is split, and more aggressive bidding follows due to narrower cost dispersions. This is the advantage of competition; but the disadvantage with dual sourcing is too little investment in controlling subsequent production cost. The post-award phase should therefore switch to a single source. The experience curve on production costs or economies of scale suffer with dual sourcing. Difference in scale economies is not much between winner-take-all and dual source. But net effect is to increase costs under pure dual source awards, unless a winner take all award follows.

How does greater incompleteness of contract substitute with competition? Incomplete specification leads to quality problems. Buyers then switch to dual sourcing. Complex programs in initial periods of production are dual sourced. Greater cumulative production per period leads to unit savings that can be transferred making dual sourcing more likely; but multi period contracts are relatively more complete and make dual sourcing less likely.

In sum, more than dual or winner-take-all sourcing *per se*, slopes of learning and scale economies are important. The learning curve is steeper for dual source and improves cost – but the splitting of quantities and scale economies makes cost suffer. When will the effects balance? It clearly depends on quantities. Therefore, for ongoing procurement with adequate supplier capacity availability emphasizing scale economies and winner take all awards is essential subsequent to a break even period of dual sourcing that reaches flatter learning curves (Lyon 2002).[5]

Multiple sourcing as a sustained alternative is gaining acceptance. E-Mall is a concept where stocks and inventories with public agencies and with made to demand private contractors can be multi-sourced. Industry electronic catalogues are integrated into EDI systems, and DoD purchases a variety of commodity items. MRO supplies for instance are ordered through prime vendors for rapid delivery, and entire bill-of-materials fulfillment. All MRO contracts have clauses to ensure surge and sustainment capability under emergencies. Corporate contracts allow reduction of repetitive effort at inventory control points and remove the need for prime vendors for separate items. The long term contracting strategy with corporate contracts allows aggregation and consolidation, direct logistics delivery and larger scale electronic commerce support.[6]

Favored supplier segments: Domestic suppliers are often disadvantaged in a particular industry with respect to costs of international vendors. Often small businesses with higher cost structures must be encouraged in competitions with large businesses. How can the disadvantage be leveled? Usually the agency allows a cost handicap ranging from 6 percent to 20 percent or more to be applied to favor the disadvantaged set of bidders. This may not be the sacrifice of efficiency that it appears to be, as the effect on acquisition cost may be good for the buyer. Widening of the supply base to include higher cost bidders has a competitive effect. Moreover, the discriminatory bidding competition forces lower cost bidders to bid even lower. A factor to favor disadvantaged bidders is

an optimal policy. When special supplier segment welfare is part of government welfare objective, the optimal selection mechanism should include such specific cost favors for cost disadvantaged segments (McAfee and McMillan 1989).

5.5 Conclusion

Government procurement is a critical domain of sourcing strategy as it has special considerations and issues. A variety of initiatives to reduce "buyer's remorse" are current at departmental, national, and international levels. The aim is better governance of the sourcing function in the public interest. The scope and volume of public sourcing by governments makes it unlikely that a supply base exists with the right competencies and with sufficient capacity. Government suppliers are also engaged in parallel markets for commercial business. Joint costs that are allocated to government sourcing programs are then often distorted since generally accepted costing principles cannot be enforced. Tradeoffs are inevitable between equitable governance of long term programs involving innovation, and acquisition costs due to re-procurements and price adjustments. Not all sourcing strategies are able to achieve required balance.

Department Initiatives to Control Buyer's Remorse

Department of Housing and Urban development (HUD) procurement reform followed for a variety of reasons

- demands for transparency
- vulnerability to fraud, waste and abuse
- slow and not responsive to needs

Between September '97 and June '98 the department conducted a thorough review, from need, to contract, to administration to close out. HUD annually awards hundreds on millions of dollars worth of contracts across many local territories. The mission requires widely varying buys from services, to manufacturing, to systems and process inputs. The department had not viewed the contracting decision as an investment decision, and the process was not earlier viewed as mission critical. A leadership team with top management commitment was now deemed necessary, and a Chief Procurement Officer was appointed, with the institution of a Contract Management Review Board.

Zero base assessments and multi year plans were required in addition to detailed justifications for contracting actions, and transparency. The use of a measurement system – the Procurement Performance Measurement Model -- was linked to the balanced scorecard approach to measure contracting performance.

The reforms identified special designs for contractual management of performance and risk.

Source: Summarized from "HUD Procurement Reform. Summary Report April 1999" National Academy of Public Administration. Washington DC.

Sourcing objectives, whether in public or private sectors, lead to expectations that buyers have of suppliers, and consequent obligations and risks. Suppliers and buyers incur a variety of costs in fulfilling their obligations. Cost drivers behind activities in sourcing are not entirely known or controllable at the time of contracting. This requires parties to develop ways to allocate risks commensurate with their obligations. The next chapter distinguishes the nature of risks, contracts and cost drivers.

National Initiative to Control Buyer's Remorse

For every government employee there are more than three times as many outside contract personnel performing functions in support of government. A current agenda is competition between federal and private sectors for functions that are not inherently governmental and are currently performed by government workers. This leads to a market-based government strategy. Agencies can devise customized and flexible competitive sourcing plans that depart from a set schedule, as of July 2003 according to an Office of Management and Budget (OMB) ruling. Governments at all levels are becoming managers of service delivery rather than being in the business of service delivery. OMB Circular A-76 describes changes for competition between federal and private sectors. Performance based results aim to save money, get better outcomes, and forge trusted partnership.

Strategic Action highlights from public–private outsourcing.

- Recognize outsourcing as a core managerial competency; build these skills internally.
- Allow managers to re-deploy some savings from outsourcing
- Call in procurement "SWAT" teams
- Procurement is a business solutions activity
- Build private sector capacity foe outsourcing contracts
- Activity based costing to establish baseline costs and performance measures
- Use a partnership model rather than an adversarial contractual model

In recognition of possible conflicts of interest the government distributes its consulting needs among multiple contractors. The same firm cannot go to the government agency and help it figure out all three – and this leads to RFPs that lack transformational solutions.

Source: Summarized from "Advancing the Management of Homeland Security. Lifting the Winner's Curse and Avoiding Buyer's Remorse: Lessons form HR Outsourcing Experience." National Academy of Public Administration. Washington DC. June 2003.

International Initiatives to Control Buyer's Remorse

Legislation on public procurement is to foster the efficiency and economy of use of public funds. Who uses public money? Central and local administrations, universities, agencies and corporations set up by acts of parliament, or legislature, and all those who appropriate government funds in part or whole for their budgets. Unlike private sector a test of good procurement in terms of financial results does not exist for public procurement. Governance here requires a tradeoff between public good and private profit and political decisions on the allocation of state resources. This involves questions of accountability, integrity and value. As questions about these are raised regardless of the true integrity and value of the officers or process, the use of audits is widespread. Audits are routine and used to ensure conformance to regulations. For this the contracting, monitoring and auditing roles are separated. Benchmarks with private sector and other public sector organizations are required.

Policies that necessarily depart from pure acquisition cost considerations include: environmental purchasing; preference for domestic industries; international trading agreements; set-asides for disadvantaged groups; and use of international technical standards.

Legislation for the process often vests with the Ministry of Finance, and in the case of conflicts of interest, in the Chief National Executive Office (Prime Minister / President). A role is envisaged for a centralized procurement policy office. Apart from the above policies it controls procedure on: contracting procedure; measurement of performance; qualification process; relationships with the supply base; and opportunity notices and organization

The chief public procurement officer (CPPO) also would develop regulations and legislation; promote professional standards and practice; joint contracts across procuring entities for aggregation economies; databases and international supply base information; encourage electronic commerce applications.

The UNCITRAL Model Law on Electronic Commerce was adopted in 1996 by the UN Commission in its twenty-ninth session to enhance the capability of all states to migrate to paperless communication and information storage.

Utilizing commercially available applications for applying EC to procurement is preferable, as it harmonizes a wider net of partners and users and is quicker to implement than customized development. Flexible workflow processes are key requirements for efficiency gains in implementation.

Source: Summarized from "A Strategy for Improving Public Procurement." International Trade Center. UNCTAD/WTO, Geneva. October 1999.

6: Costs and Performance Risks

6.0 Introduction

A contract is an agreement that parties to an exchange intend to be binding, and it forms the sustaining foundation for a sourcing architecture. Parties depart from arm's length exchanges of the spot market as they believe agreements will improve their relationships; yet relationships impose a burden to devise equitable governance modes. All agreements that involve obligations are fraught with risks, especially sourcing contracts. Who bears risks and costs of avoiding risks? Who is obligated with performance and benefits from better performance? Answers help to distinguish between confluence and conflicts of interests of parties to the sourcing contract. This chapter identifies risks and obligations that arise from such contractual exchanges, and how contracts forms differ from each other in the balance they achieve. We examine sources of risk in a variety of costs, and the role of insurance as protection against risky costs. The chapter identifies key cost drivers in sourcing and use of contemporary approaches to managerial costing.

6.1 Obligations and risks

Purchasing activities on the one hand and strategic sourcing mission on the other determine the financial burden of risks. From the contractual viewpoint, financial burden is best thought of as liquidated damages. Therefore risk translates to uncertain damages in monetary terms. There are usually distinct phases in the making of the sourcing agreement, such as the invitation, offer, communicating the offer, acceptance, fulfillment and termination. Sourcing carries a burden of risk due to private information and uncertainties at each of these stages. For instance, the invitation to bid or announcement of an auction may not bind the buyer to accepting a bid. The best bid when it doesn't specify an obligation will not have a right to the contract; but when it does specify an obligation to hold the bid price, or guarantee terms of the bid, it will be subject to a contract. Therefore, a selection risk arises from the agreed upon competitive procedure between suppliers, such as an auction, leading up to the contract (we focus on auctions and selection risk in the next chapter). A performance risk arises from unforeseen or risky events in execution of the contract. Contracting of business between suppliers and buyers may be simple or complex, depending on the variety of performance risks. A contract achieves apportioning of risks of non-

performance, regardless of fault, in an agreed manner between supplier and buyer.

The core sourcing contract is between a supplier or seller, and buyer. Even here, several roles are necessary within these two parties that may be subject to contracts. For instance, the buying center is crucial to supplier selection, and consultants under contracts may play "influencer" roles (Crosby, Evans and Cowles 1990). Internal employment contracts in the buying center and selling center are often influenced by the sourcing contract. In addition, there are external parties that contract for sourcing activity. The nature of work flows in routine activities of purchasing, as well as one time "master agreements" in strategic sourcing involve additional parties. For instance, these may include government agencies, auditors, third party logistics firms, commercial intermediaries, dealers and distributors, and subcontractors. The supply chain paradigm is compatible with the general contractor-subcontractor model of contracting. Here, the principle is the general contractor who is putting together its own bid for business downstream of the supply chain; and agents are subcontractors who offer portions of the requirement through competitive bidding. In supply contracts, the general contractor is analogous to the buying center, and an internal sourcing service for rest of the company. Subcontractors may also include internal suppliers, as is often the case in multi divisional firms.

Unilateral and Bilateral contracts: Determination of obligations and allocation of financial burdens of post-contractual under performance is sometimes an issue. If agreement between parties is intended to be legally binding, there may be a role for courts. Courts have the advantage of no economic stake and an informed view based on revealed facts. But the disadvantage is a view from hindsight. The key value of the contract is in its before the fact, or *ex ante*, incentives. An argument for eschewing involvement of courts and focusing on contracting parties is that reasonable contracts drafted by trained staffs in modern industrial and service economies, in most cases, could anticipate and successfully incorporate any value courts could bring to the table. And this task should be *ex ante*. In any case, courts usually access information provided by parties themselves. Therefore, asymmetric information, hidden information or unfolding information bearing on the contract are not a reason to feel that the court in any way can provide superior resolutions of disputes than the parties themselves.

When does a single party to exchange determine obligations and risks? A party promises without consideration of reciprocal or return promises by the other party in the unilateral contract. However, this promise is offered in return for an act. Commission or brokerage contracts are the most frequent instances of this type of contract. Performatory rights and duties require definition, as well as whether multiple agents will compete, and specification of liabilities of the parties. For instance the principal will be liable if it tried to prevent the agent from fulfilling the contract. The contract is better interpreted as a reliance-bargain, where the principal (who makes the offer) relies on the agent (who is

also the promisee undertaking performance). The time for which the offer remains open, or the time within which performance will occur is critical, and may be formalized as an option-contract.

Most contracts, however, involve mutual obligations. A contract is called bilateral if there are mutual promises between two parties, where each party's promise is in consideration of the other's promise. The distinction between unilateral and bilateral contracts appears to be trivial, especially when promises to act in return for promises to pay are exchanges. Therefore the law of contracts upholds reliance parties place on each other. A general contractor who asks for bids from subcontractors when putting together a bid is engaging in bilateral contracting, even though mutual promises are conditional on winning. Documentation is often needed to keep promises firm and binding, within the stipulated time (Stoljar 1955).

Multiparty contracts: Special circumstances of exchange arise where there are more than two parties to a contract. Multi sourcing requires the ability to coordinate more than one source of supply. For development and supply contracts multiple suppliers should be willing to share designs, or at least build compatible interfaces in some cases. Subcontracts involve multiple tiers of suppliers and some of these tiers would require agreements with the original buyer. Syndicated sourcing agreements are possible where multiple vendors enter into an agreement to supply a single buyer with a composite requirement. Supplier parties are then syndicated. Chapter 11 develops a case study of contractual terms in syndicated contracts. Obligations in uncertain environments lead to performance risks.

6.2 Performance risks

What obligation is contracted? A simple answer for sourcing is that supply performance is, or should be, contracted. There are many performance measures that are used in supply contracting, and often there are tradeoffs necessary due to conflicts within these measures of performance. This is not unusual, as strategy as a management pursuit has long recognized dilemmas associated with key performance indicators. These key indicators are usually listed as productivity, effectiveness, efficiency, and costs off supply. Performance, being so central to contracting, is worthy of deeper examination.

Classical, Neoclassical and Relational Contractual Performance: Contractual systems have evolved in their view of performance obligations and associated risks of performance failure. Doctrinal theories of contract law were axiomatic in classical contract theory; but the claim that doctrines are self evident, and rules are deductively determined, has been discredited and is untenable today. The past, present and future of the contractual exchange has replaced the characteristic focus found in classical contracts on the single instant of formation. Discreteness is a convenient fiction, and the duration of the exchange is always longer than the

instant of contract formation. In the course of this duration circumstances that prevent full performance of the contract may very well arise.

A corollary argument against discreet contracts is the limit to rational expectations capacities of the parties. In relational contracts, parties find it difficult if not impossible to reduce important terms of the arrangement to well-defined obligations. Since this is actually true of all contracts, all contracts have relational aspects. It follows that it is legally impossible to distinguish between relational contracts and other contracts. Therefore, if rules cannot be enforced with classical contracts that enshrine good faith agreements, best-effort clauses, and equitable price adjustments, and excuses for non-performance due to changed circumstances, they will likely not be possible with relational contracts. The key distinction between economic behavior and affective behavior of relationships is relevant to contracting, and while business-to-business marketing is particularly concerned with the latter, the concern of contracting is the former (Eisenberg 2000).

The fundamental problem in incomplete contracting is that contacting for relationships is not costless, and that costs to making contracts complete, if at all possible, may be prohibitively high. However, attempts are being made in contract theory to formalize the incomplete aspect of contract law, and develop rules that capture relationism. The role of courts in ex-ante efficiency, and ex-post efficiency apportioning of risk or damages from incomplete contracts is based on economic considerations (Scott 2000). For instance, the firm offer in a bid is considered binding and a free option for the offeree, who may rely on the offer to make its own commitments. The case of the subcontractor who bids to a general contractor is a case in point (Katz 1996).[1] The payoff for contractual performance disputes resolution would be tremendous if such work bears fruit. The burden that contract design must bear is the relationship it must support, and the scope for renegotiations in the specifics of the contract.

Claims: A claim is an assertion to a right. It is perhaps for compensation when it comes from the supplier, or for damages when from the buyer. In sourcing contracts, claims would normally originate from suppliers. Types of claims are contractual, common law, merit and ex gratia. Contractual claims come from provisions in the contract. Common law claims arise from violations outside the contract of things like copyrights and from tort, and are used to bypass need for specific mention in the contract. Merit claims arise for reasonable compensation when some key pricing information is not contracted, but work has been done and approved. An ex gratia claim is paid when consequences may be drastic for one of the parties and may actually be the best course even for the other, although there is no compulsion to pay. The "de minimis" discrepancy in performance of the obligation refers to a small shortfall in performance, too small to be considered a breach of contract. The obligation may also be interpreted as less than immutable and a best efforts qualifier may be enjoined to the performance obligation. The burden of claims is either lighter or heavier with effort that may

control performance. Yet uncertainties intervene in the technology that translates effort to outcome.

6.3 Sources of risk: Uncertainty and information

Most often obligations regarding performance uncertainties can be translated to cost uncertainties. Routine performance is easier to cost, but even here there may be instances where disruptions occur, such as breakdowns or malfunctioning equipment, that leads to performance challenges. It is usually possible to address these challenges with substitute solutions but these will add to costs. Information on costs on an accrual basis is usually available; however, forecasts of costs are usually uncertain. Subjective estimates of costs may be possible, and managers often analyze statistical information on previous program costs when they are available. When not available, managers may formalize intuition and hunches on costs by straightforward guesswork on pessimistic, optimistic and most likely estimates; or by specifying entire probability distributions of cost dispersions.

Cost dispersions: Dispersions of costs as a distribution can be readily characterized by a lower to an upper extreme, and a measure of variance such as the standard deviation. Often standard deviation divided by expected value captures the summary information on cost uncertainty, and is called the coefficient of variation. Special techniques to analyze past costs and develop forecasts of future costs are in use. Simple regression for forecasts of expected values and standard error of the estimate assume normal error probability distribution; and more uncertain costs may be represented as uniform distributions between possible extremes.

Take for instance the "contracting industry". A national base of firms, and sometimes a national organization facilitates biding and contracting for work. Clients are usually in the developing world for manufacturing and process plant. A typical case is the promoter has a turnkey contract with project contractors, who may subcontract with various smaller companies for portions of the turnkey contract. The big problem is variability in estimates for these turnkey projects that include up to 250 equipment items, values over $50 m and two years or so execution times under widely varying situations. Historical data is therefore inappropriate.

Total cost distributions are easily aggregated from hierarchical categories: for instance, proposal, or items in the proposal. The differentiated component price for each item could be fixed, firm, budget, estimate, allowance, civils, and site services. The process is to elicit the optimistic and pessimistic price as a percentage of the price-type quoted price point. As the proportion of fixed price components decreases the probability of exceeding the simple total decreases – as there is an inbuilt padding that appears to increase. The percent difference between minimum and maximum over the mean in the case was less than 4 percent (Catling and Westwood 1985).[2]

Flexible contracts: Problems of cost uncertainties could be mitigated with flexible pricing. Flexible pricing contracts are a variety of kinds such as vendor cost plus pricing; market pricing; preferred customer pricing; separating baseline and service contracts that may be competitively bid;[3] and short term contract-relationships.[4]

Perhaps most important is the quantity flexible contract. These arise because firms in supply chains must commit resources to production based on forecasted rather than realized demand. Individually rational behavior of over forecasting by buyers and under producing by suppliers leads to less than efficient chains. Quantity flexible contracts, and similar take-or-pay contracts for commodities, which are widely observed and used require purchase and supply commitments for a floor and ceiling on buyer and seller quantities coupled to their offering. This allows a more efficient solution. Depending on fungibility of the item sourced, the plus-minus difference between the point forecast and the ceiling-floor may vary (Tsay 1999).

Time flexible contracts and quantity flexible contracts refer to amount of a commodity the buyer must purchase in a given period. If cumulative amount is fixed but not the times of ordering, it is a time flexible quantity inflexible contract, and so on. These are typical of situations where prices are fluctuating, and there may be additional issues of risk sharing among parties. In international markets, especially, there is a good deal of uncertainty, volatility and fluctuation in prices. Prime sources of volatility are currency rate fluctuations, unpredictable capacity constraints, and absence of futures markets for commodities. In price uncertain environments supply contracts commonly incorporate risk-sharing provisions. The processes for supplier selection, contracting and quantity-and-timing of purchases gains increased relevance due to risk sharing considerations. Time flexible contracts allow the firm to purchase their inventory after observing price movements in a dynamic ordering process. In a stochastic price environment, where prices follow a binomial up or down movement of a finite amount with known probability in a given small time period, there are gains to time flexible, and quantity flexible contracting. Gains are ensured with risk sharing contracts with price caps and floors, where holding costs are traded off against risk of price increases. As multiple purchases can be made from each supplier, time and quantity flexible contracts offer a complex variety of options with multiple suppliers. By introducing "supplier flexibility" as well, acquisition costs in such supply contracts may be reduced (Li and Kouvelis 1998). Simulations show that for risk sharing contracts the time flexibility approach has benefits to offer. Multi supplier sourcing exploits quantity flexibility to lower costs in volatile price environments, and especially so when price environments of suppliers have lower correlations.

Our discussion shows that uncertain costs complicate the contracting process. Can insurers alleviate the problem of risk due to uncertain costs? There are problems with insurance against uncertainties, however. Even when the supplier

is able to determine their cost with smallest possible error, it may be of strategic interest to conceal costs when risk-sharing agreements are in place.

Insurance: The firm's desire to avoid risks associated with contractual obligations may be sufficient to seek insurance protection. Business risk insurance is often available for specific uncertainties firms face. The amount of premium insurers will charge is part of their actuarial determination, and the firm's risk aversion determines amount of premium the firm is willing to pay. There is often agreement or common knowledge about uncertainties associated with the venture, or contract, and there is then a match of premium expectations. The situation becomes more complicated when there is private information, as is often the case for contracts. One or more parties to the contract may hold unobservable information or will observe or act in an way unobservable by the other party, or the insurance agency. This leads to asymmetric information on uncertain events, or on hidden actions or characteristics. The private or asymmetric information allows suppliers the possibility of increasing their economic rents from the contract.

Moral hazard is the problem the insurer faces when it is unable to directly observe or deduce effort the insured makes in controlling uncertain costs (Holmstrom 1979). In general, difference between buyers and sellers in their knowledge of costs and control over the project leads to the problem of *moral hazard.* Moral hazard is said to be present when sellers can influence their expected costs by expending some effort, perhaps by making some investments in cost-reducing technologies, but will not necessarily do so. The buyer often cannot directly monitor effort level chosen by the supplier, except at prohibitive costs. The effort is made at some expense and the amount of effort the seller chooses will depend upon incentive offered to the supplier for cost control. The difficulty the buyer has in making the supplier expend effort in cost control is the problem of moral hazard.

In other words, with moral hazard there exists an insurance externality: if insurers do not subcategorize insured into sufficiently narrow subcategories of risk, the insured will be under insufficient deterrence and externalize their accident costs. Distinguish between first-party insurance, which covers the insured against non-liability personal losses; and third-party insurance, which provides coverage to the injurer against paying for injuries for which it is liable. Legal and economics scholars consider the products liability law regime as generally efficient. Customers are insured against most product risks through first-party insurance; but premiums do not adjust based on product choices. This gives rise to a first-party externality. Apportioning of risk is as important as deterrence. Proper apportioning of risk increases social welfare by reducing insurance cost for the risk averse and encouraging somewhat riskier activities that may have better payoffs, by freeing assets held to offset losses.

Suppliers will not invest adequately in effort to prevent product accidents since risk premiums are not individually tailored to them. Moral hazard refers to loss in effort expended by the insured due to less than full cost of accidents

imposed on them. Risk as expected damages, differs among suppliers, but may be compensated by the same premium. This cross subsidization of suppliers leads to an inefficiency, as all suppliers will desire higher premiums and expend less effort. When information asymmetry on risk is present, higher risk suppliers select into the pool and eventually lower risk suppliers select out. Information asymmetry on risk of damages type allows higher risk suppliers to compete successfully against better rivals. This is an adverse selection problem.

As suppliers have superior product information, it is preferable to emphasize third party insurance within an enterprise liability regime than first party insurance for the buyer within a negligence regime. Unless monitoring costs are negligible, and they never are, insurance pools will always be less than optimally segregated and adverse selection and moral hazard problems will always exist. These would cause problems for first party insurance premium adjustments based on consumption choices, but clearly not for enterprise liability premiums that would just be attached to the product itself. The upshot is that suppliers would add premiums to their products and services, rather than expect buyers to insure themselves. Suppliers in turn can differentially package products and discriminate among customers with different risk damage characteristics, to prevent cross subsidization and adverse selection by customers (Hanson and Logue 1990).

Often instruments like bonds, escrow accounts, direct financing of reliance, deposits, and letters of credit are used in lieu of insurance, when access may not be available on breach of contract. These approaches require better understanding of costs and risks.

6.4 Risky Costs

A key performance indicator is cost. Sellers incur a variety of costs, some of which are well known to the buyer and other that are privately known only to the supplier. Costs are direct when they arise from materials and processes that form the product, or they may be indirect overhead costs allocated to the product. Average per unit costs of manufacture is likely to be a major part of the contracted costs.

However, most sourcing today is concerned with total costs associated with a supplier rather than per unit costs. Therefore, other costs in acquisition of the product or service from a particular supplier become relevant. For instance, these include (a) quality associated costs due to returned consignments and improper quality controls; (b) logistics and transportation costs; (c) special taxes and tariffs imposed by cross-border movements, such as excise, sales and cross-border duties; (d) costs of delay, stock-outs, and inventory carrying costs of suppliers in JIT agreements; (e) accessory and ancillary costs, including life cycle costs of special equipment and value-in-use analyses costs for process variations induced by the supplier's products.

For several decades costs have been audited in sourcing for the purpose of payments to suppliers in cost reimbursement contracts. Even in fixed price contracts there may be a price re-determination if estimates are flawed. In that case a cost audit is again necessary. Allowability of certain categories of costs is specific to the sourcing program, and cost interpretation guidelines are published by government agencies. There is a great need to generalize across many contracts for fair and equitable application of principles in cost audits. Managers may tailor applications of generally accepted accounting principles for special circumstances surrounding sourcing.

Some special circumstances include bonds and insurance in costs, and there then must be an available guideline. These insurance costs may often be included in pricing elements over and above costs. Compensations of employees may be a contentious issue, especially of retirement and benefits allocations. R&D costs may sometimes be allowable and manufacturing costs always are; amortization and depreciation are contentious costs and interpretation guidelines are particularly useful here. Financial costs such as interest on working capital and other borrowings are usually disallowed to prevent discrimination on the basis of own versus borrowed funds usage by suppliers (Rampy 1950). Many of these early principles are encapsulated in legislation (Pownall 1986).[5] What measures of sourcing costs are relevant to performance measurement? We look at three: accounting; opportunity; and marginal costs (Horngren 1981).

Accounting costs: These refer to costs that are expensed, and should be accounted as costs of performance. The exercise of accounting for these costs in a given sourcing contract is a major task. Exhibit 6.1 provides a brief classification of accounting costs and approaches that sourcing managers typically encounter. However the breakdown of accounting costs, standardization of procedures will create supplier diversities from the buyer's perspective. Total costs for the contract or divisions of the contract will differ among suppliers. There will be a range of feasible contract costs, with the most efficient supplier favored by the best, perhaps risky, outcome associated with base cost. This is the lowest feasible total accounting cost. The least efficient supplier burdened with the least favorable risky outcome has the highest feasible contract cost.

Due diligence in sourcing must reveal variance in cost estimates for the overall contract, and the associated base cost and range of costs should be well agreed upon and known by all interested parties to sourcing. The specific approach the supplier adopts will lead to cost differences among them for a given programs. In addition uncertainties in predicting costs and differing efficiencies will further differentiate between suppliers, and provides an idea of relative magnitudes and variations of these costs.

Opportunity cost: An opportunity cost is the maximum contribution that will be forgone or could have been obtained by an alternate use of capacity; it is not the usual outlay or expensed cost that will be disbursed by the firm. In sourcing it is important to note that the buyer can only contract on outlay cost that may be audited and otherwise observed. Why then are opportunity costs relevant to

Classification	Typical Relative Unit Costs(range)	Source	Examples
		Categories A	
Variable	Production: 1	Manufacturing- Materials: direct and indirect (leads to contribution /marginal costing approach)	Raw materials, MRO (maintenance, repair, operating supplies)
	Labor: 1 (0-5) Inspection: 1 (0-5) Coordination: .05 (0-10) Supplier performance :.5 (0-10)	Labor- direct and indirect	Sales commissions
		Variable factory overhead	
Fixed	Set up: 50 (0-250) Inspection: .01 (0-.1) Coordination set up: 2 (0-100) Production: 5 (0-100) Returns: 1 (0-5)	(leads to absorption costing or full costing approach)	Factory overhead, capital equipment and plant, property taxes, insurance
G&A;General Selling and Administrative Fixed costs		Salaries, training, depreciation of capital equipment, indirect manufacturing costs, indirect selling costs,	Advertising, office facilities and depreciation, sales salaries, legal fees,
Classification	Typical Relative Unit Costs(range)	Source	Examples
		Categories B	
Product costs		Leads to absorption costing if fixed costs--- indirect and without the G&A-- are absorbed as inventoriable· Leads to variable costing if fixed indirect costs are immediately expensed and not included in product cost	Direct material inventory, work in progress inventory, finished goods inventory
Merchandising and manufacturing		Period costs	Selling and Administrative costs (noninventoriable)
Merchandising		Cost of goods sold	Purchase cost, freight in, insurance, depreciation and wages
Classification	Typical Relative Unit Costs(range)	Source	Examples
		Categories C	
Total cost		Fixed absorption cost plus G&A costsFixed costs plus variable cost plus G&A	Not unitized, per unit – big picture
Relevant costs		Opportunity costs versus cost outlays	

Exhibit 6.1: Types of accounting costs. Broad classification of costs helps managers in identifying how to control and manage risk. Categories A, B, and C are different ways of grouping costs. Typical unit costs are relative magnitudes, as are their range. *Source: Adapted from Richardson and Roumasset (1995).*

sourcing performance? Observed costs may include direct and indirect components and some indirect components may be joint costs that are allocated to sourcing. It is due to the effect of joint costs we seek to distinguish opportunity cost from these former costs (Cohen and Loeb 1990).[6] Allocation of joint costs between sourcing and spot market production will determine a supplier's estimate of the sourcing's opportunity cost. For positive returns, profits from sourcing should be sufficiently higher than this opportunity cost.

The supplier's performance will clearly be influenced by this determination. A related idea is incremental cost between two alternatives, which leads to incremental or marginal analysis.

Marginal costs: Marginal cost using the contribution costing approach is widely popular in incremental analysis. It allows suppliers to apply optimal pricing theories, where marginal cost is related directly to marginal revenue. The extent of effort and resources devoted to sourcing performance will be determined by this marginal cost – marginal revenue equality. The importance of fixed costs should not be ignored, however. When entry is at issue, the relevance of whether consumers are willing to pay for fixed costs gains relevance. In addition, suppliers may incur non-chargeable marginal costs, such as entry capacity maintenance (Coase 1946). If the buyer pays only for marginal cost of the sourcing program, these fixed and non-chargeable variable costs are a burden to society, and may eventually be a reason for upward pressure on acquisition cost. Clearly, approaches that minimize these costs should be encouraged. The approach that includes full costs is termed the "balanced budget" rule. When the firm has moral hazard in fixed cost choice, the balanced budget rule will result in a price hike for the buyer for inefficient firm choices in fixed costs. The price hike could serve to reduce demand or increase risk of non-selection, giving the supplier incentives for better fixed-price decisions (Laffont and Tirole 1993).

In sum, accounting or opportunity or marginal cost measures impact performance measures differently. Risks and incentives balance for performance differ for the three measures. The differences further justify the quest for cost drivers.

6.5 Cost drivers

The importance of identifying cost drivers is obvious for cost control effort. Product costs are based on direct labor, direct material, and allocated manufacturing overhead. How would managers account for customer value not related to physical manufactured product? How to cost value added activities in intermediate stages with non traded characteristics? And how should managers allocate and control period costs to the product, such as factory overhead? Synergies between sub units change costs and values of activities, but models are needed to capture these effects. Costs across units of activities are rarely captured;

and available tools such as services allocations and product transfer prices are very basic.

	Cost Driver	Description
1	Economies and diseconomies of scale	Impact of scale on costs of performing activities; increasing complexity can lead to diseconomies
2	Learning and spillover	Reduction in cost of performing an activity due to learning and experience. Learning from other units experience is called spillover.
3	Pattern of capacity utilization	High changeover costs and high fixed costs provide opportunities for joint optimization of several functions such as production, sourcing and marketing
4	Linkages	The cost of an activity is related to how other activities are performed in the value chain and the value chain of suppliers and buyers
5	Interrelationships	And SBU may benefit from sharing scarce resources with another SBU in the same firm
6	Integration	Vertical integration affects transaction costs; buying and making decisions
7	Timing	First mover advantages and follower advantages depend on the circumstances
8	Discretionary policies	Product specs and technology decisions and other decisions that do not affect other cost drivers
9	Location	Skills of the labor force, logistics and local differences in production
10	Institutional	Regulation, unions, government policies etc

Exhibit 6.2: Cost Drivers. Management and assessment of risk depends to a large extent on identifying underlying cost drivers. *Source: Porter (1985) "Competitive Advantage" as summarized in Hergert and Morris (1989).*

When markets for intermediate products don't exist cost is a surrogate for value – and cost has to be estimated by (a) cost drivers for resources that go into the activity and (b) amount of resources required for the activity. Exhibit 6.2 summarizes the more important cost drivers.

Cost driver data: Cost drivers are not part of product or period costs and therefore cost accounting systems rarely have the necessary information for estimates. Statistical data is usually difficult to get, as data are time stamped and changes in firm and environment complicate data interpretation. Responsibility center budgets are not adequately translated into activities from the organizational chart, and costs of activities are not reflected. Yet the fruits of even rough estimates are considerable. Total cost of ownership includes cost driver information, and in the sourcing process it involves costs at three different levels:

1. supplier level costs – including pre-qualification, management, account creation, saving from supplier services;
2. order level costs – including ordering, receiving, invoicing and so on;
3. unit level costs – including average price per SKU unit of item, salvage costs, discounts due to credit in period, inventory carrying costs.

All these costs may be re-aggregated to total purchasing costs, total inventory costs, and total unit costs (Degraeve and Roodhooft 1998; Richardson and Roumasset 1995).[7]

Historically, cost accounting was used to develop budgets. Cost center budgets for product costing, and responsibility center budgets for control led to a grid of cost accounting cells. Traditional costing systems are not only unhelpful for strategic decision-making, but they can actually hinder them. They are specifically set up for:

1. managerial planning and control;
2. preparation of financial statements for distribution to outsiders;
3. preparation of business income tax returns; and
4. determination of reimbursable amounts under cost based contracts, or similar pricing, or funding arrangements.

In general, there are three types of accounting data – financial, cost, and management. In contemporary firms, cost data is used for financial and management accounting. Financial data is accrual data in aggregate to communicate to external constituencies on past performance. Cost drivers are central to management accounting systems. Clearly, management accounting is the most relevant to guide sourcing strategy (Hergert and Morris 1989).

Value and activities: Value chain analysis is a method of decomposing the firm into activities, such as sourcing, design, production and marketing, and using costing to determine strategies such as low cost, differentiation or hybrids. The approach is described in the now classic book, *Competitive Advantage* by Michael Porter (1985). Managers need to identify activities that are potential sources of competitive advantages leading to attractive economic rents. Linking these activities downstream and upstream as well as across strategic business units (SBUs) leads to synergistic core competencies. To arrive at more accurate

costs across organizational units, managers should distinguish product based organizational units from SBUs they can formulate on the basis of value chain analysis. A first step is to determine the best SBU structure using value chain analysis (VCA) considerations, and this may require a restructuring of the firm's organizational units. When critical activities span activities outside boundaries of the organizational unit, or when they are not formally recognized, cost accumulation that goes into responsibility centers for budgetary controls is inadequate. Redesigning the organization is necessary for redrawing boundaries to include all of the value chain activity. Cost centers and critical activities also do not historically correspond for the firm for many reasons. For example, management education is spread across many units, across many functions, and often for primary and support activities without distinction. The same is true for purchasing. The value chain activity approach improves the manager's ability to control total costs of ownership, and therefore overall performance for a given contract.

Activity costs: Simple marginal costs may have difficulties when firms undertake activities under uncertain demand. Normal costs have components that vary proportionately with demand for production, and other components that do not vary proportionately. The portion that does not vary is instrumental in capacity decisions. Making this distinction is useful for uncertain demand situations. How is cost, especially this non-varying cost, to be allocated when demand exceeds the predicted norm? Managers should consider incremental costs such as rental of additional resources, overtime and other short run support activity supplementation, in addition to normal cost for situations where initial capacity is to be adjusted.

A managerial concept is that of a sufficient cost statistic—a weighted sum of unit costs in providing a unit of output. Weights have to do with relative portions of support activities; and unit costs of support activities come from aggregated figures. No one answer fits all situations: full costs or variable costs can be better approximates for opportunity costs under different circumstances. Marginal cost is the allocated average cost under full capacity, when capacity cost is linear. This parallels the marginal cost equivalence to normal cost, at full capacity *ex ante* predicted usage. Marginal cost of adding initial capacity is equal to the expected penalty adjusted cost of exceeding initial capacity once demand is known.

Activity cost components are:

- Variable costs – cost driver is output
- Fixed costs – cost drivers are same as for resources in initial capacity, leading to normal cost
- Support activity penalty costs - cost drivers are output and cost drivers of resources when initial capacity is exceeded

Activity based unit cost is equal to variable cost plus sum of normal unit cost per activity times the units of activities, summed over all activities.

The profession recognizes, and has long recognized difficulties with marginal cost and the need to transcend simple approaches. A strategic view of costing is evident in the following quote from The National Association of Cost Accountants.

"Judgment and understanding is required in using marginal costs for pricing purposes. It is necessary to consider long range aspects of such business in order to avoid commitments which cannot be dropped... Supplementary allocation of fixed overhead on normal or other volume base must be made to provide product costs for long range planning decisions." (April 1953; Quoted in Banker and Hughes 1994; p. 480).

Administrative Costs: Competitively bid large orders, with inspections (the so called American system of sourcing) can be substituted with a policy of small repetitive orders with no inspections (the so called Japanese system) under some circumstances. A typical General Motors (GM) assembly plant deals with about 800 suppliers. Toyota produces less than 25 percent of its car parts (about a third of GM), and deals with only 125 suppliers at its assembly plant (Taylor and Wiggins 1997). The more vertical integrated a firm, the more parts it produces internally and so has to outsource more materials and components. Yet degree of vertically integration is only one explanation of the choice between American and Japanese systems of dynamic sourcing contracting. Set-up and inspection costs are central to production runs and quality control, and serve to explain the choice between American and Japanese dynamic sourcing systems. If a shipment is accepted without inspection, the right to reject is waived according to the Uniform Commercial Code (sections 2-513 and 2-601).

Deming identifies advantages of single supplier sourcing over multiple suppliers, from cost and quality improvement incentive perspectives. GM Saturn is reputed to be 100 percent single sourced. Coordinating closely with a single supplier for quality improvement and innovation reduces salvage costs and compensates for lost competition, according to these viewpoints. But these prescriptions are by no means obvious or universal. We have already documented many advantages of multiple suppliers for strategic sourcing (see Chapter 2). A view that includes agency costs, the sum of monitoring and coordination costs on the one hand that increase with numbers of suppliers, and shirking costs that decrease with suppliers, is the key argument in favor of more than a single supplier. Agency costs include set up costs, switching costs, and a variety of warranty, rework, inspection and such costs that give suppliers incentives to shirk. The counterpoint to Deming's single sourcing recommendation arises largely from explicit consideration of shirking costs that benefit from multi sourcing governance structures (Richardson and Roumasset 1995).

Cost drivers can usefully be grouped as common costs and specific or idiosyncratic cost drivers. For instance, commodity prices that affect all suppliers in a product class are common costs; as are some elements of the supplier's working costs of capital. Specific costs depend on productivity characteristics of the supplier. Intellectual property and learning curves bring differences between

companies on costs. The usefulness of such segregation will be more apparent in later chapters.

6.6. Conclusion

There are several costs that buyers and sellers distinguish for the purpose of allocating obligations and risks. Sourcing strategy approaches contracts as a flexible self-governance modes, allowing mutually satisfactory outcomes in allocations. The presence of uncertainties leading to performance risks makes such self-governance of sourcing relationships necessary. The supplier's approach to costing and the buyer's recognition of specific costs drives many of strategies open to the parties. Risks and rewards of sourcing require economically significant grouping of costs, such as accounting costs, opportunity costs and marginal costs.

We next examine implications of these cost uncertainties and estimates prior to the contract. We also recognize the importance of asymmetries of cost and cost control information that persists after the contract period. The supplier's incentives for effort can change with the contract form used to govern the sourcing relationship, and we describe standard approaches to risk-incentive tradeoffs from contracts.

7: Contracts and Incentives

7.0 Introduction

Uncertainty in costs and risky cost drivers notwithstanding, contractual agreements must be made prior to the contract period. Balance of risks and obligations in contracts can shift with the seller's effort at controlling the source of risk and better management of cost drivers. If all costs and cost control activities were verifiable at the end of the contract period there would be little difficulty from uncertainty. A sourcing situation that can rely on observable and verifiable costs and activities is wishful thinking, however. More often than not the seller's effort cannot be directly compensated, and a burden of contract design is to provide right incentives for effort. What particular contract designs may buyers use, and what incentives do these designs provide? The chapter deals with these issues central to form of the sourcing contract. We conclude with descriptions of typical sourcing contracts for manufacturing, and for IT services.

7.1 Incentives for effort

Sellers could incur various costs in improving performance, and consequently, bear costs in improving the buyer's sourcing experience. As most of these costs are passed on to buyers, investment in better estimation of program costs and elimination of error would help the buyer's budgeting process and improve chances of cost controls. Investment in better technologies for monitoring and controlling costs would reduce overall program costs. Quality controls and quality assurance programs within supplier organizations require initial investments in training and business process re-engineering (BPR), and the advantages are well documented in the six-sigma literature. The entire supply chain benefits from these efforts, as they reduce risks and improve performance. The simple interpretation of effort is as a productivity parameter that enhances performance for a given cost; or reduces cost for a given performance. Effort involves a cost that is usually incurred privately by the firm. Therefore the question: who should bear cost of effort? Relevant to the answer is whether effort and its costs are observable or verifiable.

Observable effort: When effort is directly observed, it can be compensated. Usually effort is observed on completion of the obligation, and its compensation is *ex post* or after an audit. However, efforts made by vendors in these

performance-enhancing and cost-reducing pursuits are not always visible to the buyer, or an audit may not be planned. The buyer's cost of monitoring supplier effort is usually prohibitive and therefore is often left unobserved.

Verifiable effort: Since there are economic uncertainties, true effort cannot be deduced from final cost outcomes even when they are audited on completion of the program. Effort actually undertaken, and effort costs incurred can therefore nether be observed nor verified by the buyer. It will be impossible to accurately establish effort costs for the satisfaction of any dispute resolution body, and therefore there is no recourse to courts for unverifiable costs. The presence of unobservable and unverifiable effort costs lead to the moral hazard problem. This problem refers to the major question of how sellers can be given *ex ante* incentives to spend costly effort that will benefit, but cannot be directly compensated by the buyer. A significant part of the design of sourcing contracts addresses this moral hazard problem. The contract that accounts for moral hazard seeks to apportion some risk to the firm that can expend such effort in order to provide it an incentive to do so. Design of contracts addresses issues involved in balancing risks and incentives.

7.2 Risks and types of incentives

The sources of risks for sellers are many, from supply side uncertainties on costs to buyer side uncertainties on demand and timely payments. It is well known that riskier business projects must generate higher returns than riskless ones, because business decision makers are risk averse.

Risk aversion: Sellers are risk averse when they are willing to settle for a lower profit for certain than what they might expect to obtain as profit from a contract subject to uncertain events. Equivalently, a supplier will add a risk premium to price of a binding option it offers to a buyer, and if possible delay any investments it makes that would induce wasted reliance. In other words, contractors derive a utility from a smaller but certain profit that is equivalent to expected utility from a larger payoff that contains risks of wasted reliance from uncertain bidding competition or other performance uncertainties. The monetary amount the seller would sacrifice to rid itself of risk, or by which it pads its bid due to risks it cannot be rid of is its risk premium. The buyer would usually need to provide some additional compensation as insurance against risk in order to reduce padding the seller puts into bid prices to cover its exposure to risk. In sum, when sellers are risk averse they would prefer a payment scheme that reduces uncertainty in their profits.

Risk sharing between buyer and seller, or between sellers would often help in improving the sourcing process. Apportioning of risk should be higher for the party that has a lower cost of risk, or risk premium. Parties will differ greatly in their ability to bear risk, due to wealth endowments, access to credit and insurance markets, and diversification of capital structure. Usually large

corporations and government agencies are practically risk neutral, whereas small proprietorships are highly risk averse. A cost plus contract places no burden of financial risk on the seller and therefore associated risk premium for the seller is zero. On the other hand, a fixed price contract places all of the risk burden on the supplier and therefore associated risk premium required by such a supplier would be high. Risk premiums can depend on perception of risk as well as risk aversion. It appears that perception of risk depends on trust between parties, and disclaimer clauses; and is the more important in determining risk premium (Zhagloul and Hartman 2000). The role of risk premiums in optimal contract designs is a crucial modeling issue, and is dealt with in more detail in later chapters.

Risk apportioning: How can risk be apportioned? A legal approach is though exculpatory clauses. These clauses enable transfers of risk such as legal liabilities. If the party has no control over the source of risk shifted by the disclaimer clause, they must either insure against it or add a risk premium. Inappropriate risk apportioning amounts to wasted cost. A balance in risk apportioning is needed, as the party with lower risk premium should bear more of the risk to reduce compensatory insurance; yet the party with greater ability to control risk should have an incentive to do so, that only risk bearing will impose. Risk cannot be eliminated but may be shifted, for example though disclaimers and contingency to the bid price. Some studies show that the additional risk premium may be 8 to 20 percent higher as a consequence in the construction industry (ibid.). Appropriately designed contracts can dramatically reduce inefficiency from faulty risk apportioning.

The contract serves at a basic level to provide incentive for the principal to make an offer that is defensible and for the agent to take actions that rely on the offer. If redress for reliance is not protected by law, the cost of wasted reliance will be added as insurance to the price. Cost of performance is lower when suppliers or subcontractors do not have to insure against the general contractor's lost reliance. These have advantages in a competitive bidding situation where the general contractor is the principal who has to make a bid that relies on subcontractors without actually accepting their bids, and the subcontractor is the bidder with the right to revoke his bid. Exhibit 7.1 summarizes the risks.

Liquidated damages, or risk itself, is the amount parties agree, at the time of contracting, will be payable in compensation in the event of a breach. Payment and performance bonds are agreements between the owner and an insurance company (the surety) that is provided by the contractor. Payment is provided via surety to subcontractors in the event of inability of the contractor to pay. The threat of liquidated damages and allure of bonus add significant tangible incentives to contract performance.[1] The usual alternative to liquidated damages is a penalty clause that is usually unenforceable.

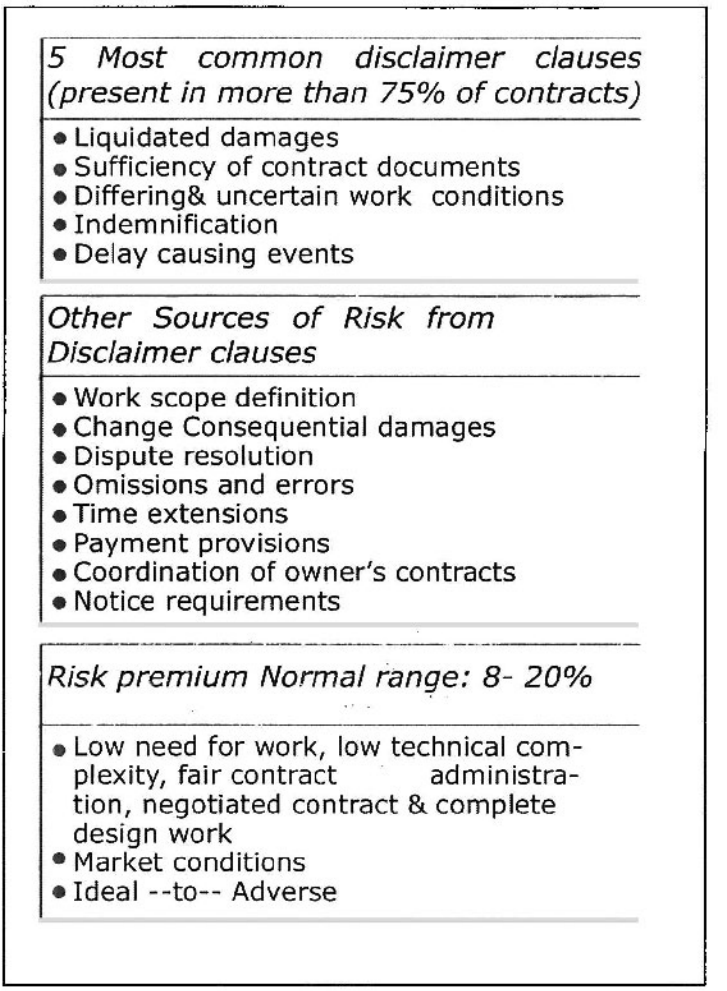


Exhibit 7.1: Disclaimer Sources of Risk. Contracts manage allocation of risk though disclaimer clauses. Parties may trace risk to disclaimers. Risk premiums as a percentage of contract value represent the impact of these disclaimers, and risk is reduced by contract characteristics and market conditions. *Source: Zaghlol and Hartman (2002).*

The amount of damages should be related to loss incurred due to delays; but loss is often impossible to verify. Only then do courts or boards leave determination to the parties. Measures of harm to the public in government sourcing caused by delays are easily challenged by alternate measures provided by a culpable contractor.

Damages accrued at the stage where facilities have been occupied and only minor jobs remain, the "punch list" stage, are assessed as penalties. The substantial completion implied by this doctrine to demarcate the punch list stage

is problematic and contentious, and often the surety also gets involved. Inclusion of progress payment adds an ambiguity problem to liquidated damages, when payments are due. Contractors believe that owners cannot withhold payments as long as they keep working. By legislation, the owner may be allowed to use self help in withholding payments, and make it necessary for the contractor to justify why payments due should not be withheld. It also allows a good faith approach by owners, even public agencies, who may choose not to withhold. The stipulated schedule of damage should be based on contract price categories (Tyler 1994).[2] The point in all these damage payment norms is to provide incentives to avoid such situations in the first place. Risk is introduced and managed to aid performance.

7.3 Tradeoffs with risks

Performance outcomes matter to buyers (Noordewier, John and Nevin 1990). Vendors can improve performance outcomes, and reduce contract cost, by spending effort. As costs of effort are borne by vendors they are often unverifiable. Therefore, if risk has been apportioned mainly to the buyer, the vendor then has an incentive to shirk effort. Buyers recognize this and make compensation dependent on performance outcomes, transferring some risk back to the seller. As a consequence the very uncertainty that makes effort unverifiable, also serves to increase vendor risk when compensation is based on performance. Why would buyers who are likely to be risk neutral ever desire to allocate a risk burden on the seller who is risk averse? Our discussion argues that the reason for deliberate inclusion of risk, as a departure from cost-plus contracts, is the vendor's effort in reducing risk that such departures induce.

Supplier risk-incentive tradeoff: Two additional components are therefore added to required returns (or economic rents) due to the moral hazard problem. Whatever the supplier's chosen level of effort its cost is to be borne. In addition risk premium associated with the incentive has to be borne. The vendor's effort balances its cost of effort on the one hand with the degree to which it can reduce its risk through effort and therefore reduce its need for insurance on the other hand. Marginal cost of effort is usually increasing and marginal benefits of effort in reduction of estimated risk are usually decreasing.

What are costs of effort? In order to reduce cost each vendor can expend effort on innovation, which manages to reduce contract performance cost. Perhaps a portion of effort cost is opportunity cost of effort but the major portion represents cost of innovation. Vendors can engage in due diligence, but often additional work may be necessary to reduce errors. In competitive situations, effort has to be chosen prior to selection and performance leading to a realized contract cost. This is at the very start of sourcing when competing vendors are very similar in an expected or stochastic sense. Effort chosen by the supplier could be its only major source of competitive advantage. If too little effort is chosen, the vendor may be

disadvantaged in the competition with other vendors that chose to apply more cost reducing effort. However, if all the competing vendors expend all efforts, they will bid away any relative gains.

Buyer risk-incentive tradeoff: In turn, the buyer attempts to minimize its total cost of compensation, which includes adjusted cost (subsequent to the supplier's cost control effort), and vendor's built in required returns, which include cost of chosen effort, and the premium that insures the vendor against residual risk. The buyer benefits from a lower adjusted cost due to the vendor's efforts, but has to now pay additional components to the supplier's rents. The buyer should therefore choose to transfer just that amount of risk to the supplier that allows it the best tradeoff. Design of the contract depends critically on these risk-incentive tradeoffs for the supplier and the buyer.

Should the buyer transfer all the risk or none of the risk to the supplier? When vendors are able to build in risk premiums in their prices, and the fixed price is "discovered" through some process—such as bidding—the incentive for cost control comes at the price of the risk premium. Suppliers will pad their bids to cover costs of effort and risk premiums. Then it may be preferable for the buyer to shoulder some of the risk burden in order to reduce the vendor's risk premiums. This reduced risk will surely reduce cost control incentive, but reduced risk premium may more than compensate, leading to a lower overall buyer price. In the case of extreme vendor risk aversion or extreme uncertainty, the buyer shoulders all risk leading to the cost-plus-fixed-fee contract. There is no incentive for cost control here, since the vendor faces none of the risk from cost escalation; and vendor profit is assured by the fixed-fee since costs are met in full. Clearly, the buyer shoulders none of the risk in the fixed price contract.

An intermediate solution is the incentive contract, discussed more fully below, where cost over-and under-runs relative to a target price are compensated with a sharing rate, which corresponds to the vendor's share of over-or under-run. Sharing rate is unity for the fixed price contract, and zero for the cost-plus contract. A profit rate is usually also defined for the incentive contract that is applied to the target price. Risk is therefore apportioned between buyer and seller, and incentive for cost control is balanced with risk premium built into contract price. This type of vertical risk-apportioning is typical of single agent incentive schemes. The buyer must create risk in order to introduce incentive for cost control effort.

Risk and benefits: What if effort yields benefits but has little impact on risk, or when a risk element cannot be reduced with effort? One such form of effort and risk is wasted reliance where effort may reduce cost, but parties may rely on some events outside their control, which will determine magnitude of contract profits or whether the entire contract is frustrated. In a sense bargaining power of the parties is also reflected in this apportioning of such risk. For one thing, superior information is superior bargaining power (Katz 1996).[3] If the seller can appropriate little of overall surplus value subsequent to performance of the contract, then more of the risk of wasted reliance loss from breach of contract

should be allocated to the buyer as more of the benefits from success would also go to the buyer. Ability to appropriate surplus and the amount of surplus depends on effort the supplier puts in, which may be hidden, or at best not well monitored by the buyer. The seller then has greater ability to appropriate rents from hidden effort, and should bear more of the risk from wasted reliance.

Vertical and horizontal risk: The incentive contract is a way for the buyer to introduce a controlled amount of *vertical risk* in the vendor's compensation plan. Risk is necessary to provide incentive for hidden or unverifiable effort by the vendor for cost control, provided effort can actually reduce the agent's risk. The fixed price contract places the entire burden of financial risk on the vendor; the buyer suffers no financial risk under the fixed price contract. When costs are uncertain, the vendor's profit is equally uncertain. Incentive for cost control is highest when vendor's risk is maximal, and many buyers exploit this incentive, getting the vendor to spend costly effort to reduce vertical risk.

The multiple agent incentive contract allows the buyer to introduce cost control incentives by creating *horizontal risk* between agents. Relative performance measures can now be defined. Whether buyers consciously seek contests or not, some degree of rivalry exists whenever multiple agents are appointed. The contest, where an agent gets a prize with only some probability if it wins the contest, is an example of such horizontal risk. The agent's risk premium could be quite different than in the linear incentive contract case, since the contest prize makes reward independent of marginal performance, or marginal cost. Incentive for cost control is not automatic, however, since marginal cost of effort balanced with marginal benefits of effort is not the risk-deciding factor any more. Agents will expend costly effort only if they can reduce horizontal risk. Intuitively, there must be some common factor influencing costs for agents before there will be any incentive born out of horizontal risk, such as that created by a contest, or a tournament, or a promotion. Size of horizontal risk from a winner or loser payoff and common uncertainty in costs are critical influences on the risk-incentive tradeoff for multi-agent incentive contracts.

Therefore, vertical and horizontal risks may be apportioned to the supplier using specific contract designs in order to generate incentives to spend costly effort in performance. The tradeoff is in additional supplier risk premium that the specific contract design also imposes. What are designs of contract, and what degrees of control do they allow over tradeoffs? The number of agents, nature of uncertainties and structure of information asymmetries are crucial to contract design.

7.4 Designs of Contracts

Contracts may be verbal or written and conveyed in person, through telephones or paper or electronic media. Documents may be exchanged with contractual agreements, and are usually employed where contracts are sufficiently

large and complex to require evidence of agreements. Standard documents for routine contracts, such as with a real estate agent for a house sale, are available for sale as stationary in retail outlets. In most cases, documents are meant to be signed or under seal and specifically referred to as contracts or evidence of contracts. These versions of the contract are called the form of the contract, or the physical form. Sourcing contracts also have an economic form or design that allows specific incentives and approaches to risk apportioning, more to do with nature of the agreement. We now introduce common designs types for contracts.

Fixed Price Contracts: Fixed price contracts are by far the most common contract type, and growing in importance even in areas where other types of contracts have traditionally been used. A chief advantage is that a cost audit is not necessary for the fixed price contract. The burden of financial risk is entirely on sellers. Thus, if there is uncertainty in actual cost outcome for the contract, the seller must bear the entire financial loss if actual cost is higher than estimated and agreed as a target price at the time the contract is made. Fixed price contracts find use when sellers are risk neutral. Risk neutrality indicates sellers are indifferent to risk and interested solely in expected profits. This makes the seller unwilling to pay even the smallest premium to avoid risk. The buyer then has no reason to reduce uncertainties in the seller's contract costs, as the seller is not likely to bid less or pad its bid any differently. All that matters to the seller is the mean or expected cost, and resulting profit.

Cost-plus Contracts: The cost audit cannot be avoided in this contract design. Attendant problems of maintaining detailed accounts, allocating fixed costs and period costs, and so on, are therefore inescapable. Distinguish several types of cost based contracts such as cost reimbursement, cost plus profit fee, and cost plus incentive fee contracts. Cost reimbursement contracts compensate the supplier for its own comprehensive actual audited cost, whether or not it exceeds estimated or target cost. Cost is the total compensation suppliers can expect, and so it is a cost-plus nothing contract. The usual form for such contracts in the IT industry is the so-called Time and Materials contract. The cost-plus profit fee contract adds an agreed profit (the plus part) to cost. The fee over cost is determined by many different methods, such as a fixed fee or a percentage of audited cost.

In the IT outsourcing industry, one study found that detailed fee-for-service contracts (flexibly priced, with detailed scope and level of service, and based on a performance measure) had better outcomes than other types of similar fixed fee contracts. Other types are strategic alliance/partnerships and buying-in of vendor resources. Most successful decisions – the overwhelming majority – were due to detailed fee-for-service contracts (Lacity and Willcocks 1998).[4] The study found that shorter-term contracts of less than 4 years and contracts that allowed internal bids as well (instead of comparing outside bids to existing internal IT costs) delivered better outcomes. Interestingly, selective outsourcing was better than total outsourcing or insourcing, indicating a dual sourcing approach of a special nature where one of the sources arises from an internal bid.

Some categories of fees in outsourcing are:
1. Transfer license fees
2. Cash payments for assets
3. Consulting fees
4. Benchmarking fees
5. Legal fees

The particular variant we call the cost-plus-fixed-fee contract has a firm fixed fee over audited cost, and allows the supplier to shift the entire burden of financial risk caused by uncertain cost on the buyer. These fixed fees may be directly bid fees established at the time of a selection competition; or fees may be set by administrative fiat. Often the fee may not be a known magnitude but is provided as a percentage over audited cost. A fixed fee is anyway better than a percentage fee due to the perverse incentive a percentage fee could introduce to cost inflation.

There is scope for other ways to set the fee that allow risk to be re-introduced for the supplier. The cost-plus incentive fee contract reimburses each supplier with its cost, and then gives it an incentive fee that is pure profit. The incentive fee may be based on under-run relative to an individualistic target cost. Alternatively, incentive fee may be a bonus fee awarded as prizes to the best suppliers on some relative comparison criteria; or a portion of a predetermined pool of funds that have additional associated incentives. Design of cost plus incentive fee contracts is a vibrant area of contract design, where different incentive types are tailored for different information asymmetries and uncertain cost environments. When multiple contracts are in place in the same period, combinations of fixed price along with cost plus designs could be in use by the firm during the same period.

Incentive contracts: A common contract form that incorporates incentive for cost control is the *incentive contract.* The incentive contract was devised to overcome inefficiencies of the cost-plus-fixed-fee contract which led to frequent cost overruns, and inefficiencies of the fixed-price contract, which discouraged sellers from bidding because project cost were too uncertain. The incentive contract rewarded sellers when their actual costs were below target costs and punished them when they were above. It quite literally is a calculated mix of the fixed price and cost plus fixed fee contracts.

The incentive contract is a contract that allows buyers to adjust the supplier's profit subsequent to completion of the contract. The profit fee is raised or lowered depending on whether there is an audited cost under-run or over-run with respect to a supplier determined target. The target also often provides the basis for supplier selection. For this reason, the sellers bid price is often called target cost. A linear payment schedule where the buyer pays a fixed fee in addition to some proportion of audited project cost is called the linear incentive contract. A linear incentive contract requires the profit fee be a fixed percentage of target cost (called the *profit fee rate*); and the adjustment be a fixed percentage of under-or over-run (called the *sharing rate*). The sum of the profit fee rate and the sharing

rate is sometimes called the profit rate. A sharing rate of unity makes the linear incentive contract equivalent to the fixed price contract; a sharing rate of zero makes it equivalent to the cost plus fixed fee contract.

The critical element in selecting and evaluating a contract form is the amount of risk each party to the contract must bear. There is uncertainty in how audited cost will turn out with respect to target cost. The linear incentive contract apportions the financial burden of risk that rides on this uncertainty. Sellers are risk averse when they are willing to settle for a lower profit for certain than what they may obtain as expected profit from a bidding competition. In other words, they derive a utility from a smaller but certain profit that is equivalent to expected utility from an uncertain bidding competition. For instance, risk averse sellers would prefer a payment scheme that reduces uncertainty in their profits. They would therefore prefer sharing rate to fall to zero, placing no financial risk on themselves. The problem for the buyer with reducing sharing rate is that is that the seller now has less incentive to control costs. On the other hand, a fixed price contract places all the risk burden on the seller. The more risk averse sellers are, the higher their fixed price bid will be. Thus, if the buyer can encourage sellers not to inflate costs, cost plus contracts are more appropriate for highly cost-uncertain projects, as in the aerospace industry; fixed price contracts are more appropriate for cost-certain projects, as in the road construction industry. It is natural to seek a balance between cost-plus and fixed price contracts. A simple way to do this is to combine the two in an incentive contract.

A reduction in sharing rate makes sellers raise their bids due to a smaller incentive for cost control. Reduced sharing rate also leads to an increase in the proportion of the supplier's cost that is covered by the buyer. This has an effect that is similar to reduction in variance of expected cost distribution among bidders and forces them to bid lower. Exhibit 7.2 is a schematic view of these contract designs.

A situation may occur where suppliers are optimizing a long-term objective that embodies payoffs beyond the purview of the sourcing contract. An example is when the supplier is investing advance payments from the buyer in research facilities suited to extra-contractual business, or developing capability to compete in unrelated business. A "contingent claims" contracting mechanism may solve this problem, with a schedule of incentive contracts, with different target cost - sharing rate pairs for different product configurations. When sufficient uncertainty reducing technical activity (measured by effort) has been undertaken to enable a choice, a particular pair associated with the product design is adopted. This permits risk sharing while providing stronger incentives for the supplier to control costs than can be obtained by a single incentive contract (Cummins 1977).

Shared-savings contracts: Indirect materials can be distinguished by the possibility of lowering their consumption without affecting production volumes. For instance, some chemical solvents, paints and office supplies are indirect materials. A program to lower consumption of indirect materials will lower overall costs in the supply chain. However, without the right incentives there

would be little incentive for suppliers to participate. New contract forms in the chemical industry typify these developments, where chemical management fees replace quantity-based contracts. Ownership of chemicals is retained by the suppler, and the buyer pays for services. Shared savings contracts help improve the efficiency of such arrangements. Shared savings contracts require dynamic renegotiation of price as savings are affected by contract design. Efficiency of shared savings contract design is measured by how much incentive they provide to both supplier and buyer to expend consumption reducing effort. Such contracts are actually used in practice and reported in the literature. In numerical experiments, shared savings contracts achieve 73% of achievable profit improvement (Corbett and DeCroix 2001).

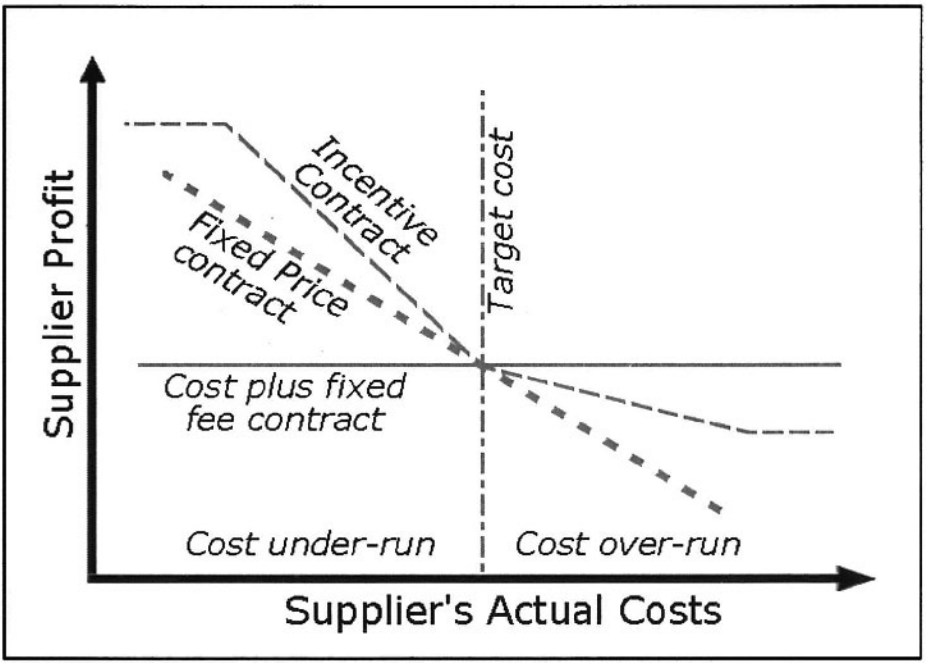


Exhibit 7.2: A comparison of common contract designs. The lines represent actual cost and supplier profit pairs for different types of contracts. The slope of the fixed price contract profit yield is 45 degrees as increase in realized cost reduces profit by an equal amount. The cost plus contract has a constant profit yield independent of actual cost. The incentive contract shown reduces supplier's risk, with a sharing rate for cost under-runs relative to target cost that is favorable to the supplier; and a sharing rate of cost over-runs also favorable to the supplier.

Yardstick contracts: Analysis of contests in multi-agent compensation schemes show that its use can improve upon the single agent incentive scheme. When there is some common uncertainty that agents privately learn about, they may seek information rents from this knowledge. Rewards from a contest are not

dependent on actual costs, but on the prize to the winner. This serves to make effort independent of marginal cost, but dependent on effort of other supplier as well as on his/her own effort. The contest results in agents competing away their advantage over the buyer, despite their initial advantage of one-sided cost information. This improves the incentive properties of contests if collusion is ruled out (Nalebuff and Stiglitz 1983). Contests among agents are not optimal in general (Laffont 1989; p.190-93). Only if there is some information to be gained about one agents performance based on the other's, is there an advantage in relative performance schemes, such as contests and tournaments (Lazear and Rosen 1981). A common uncertainty (or "noise") is therefore essential for the relative performance incentive of a contest to be optimal.

What are common costs? Often direct material costs that are purchased by suppliers come from common sources, or are commodities that have uniform prices. These commodities will have fluctuating prices and are candidate sources for common price uncertainties. Other common cost uncertainties arise from goods that are imported and currency exchange fluctuations, tariffs and taxes, and common components or sub-assemblies where monopolies may exist in the supply chain.

Multi-agent models of supplier performance incentives are more recent. Two stage models of second sourcing have been studied where a second supplier is introduced during the post innovation or production phase (Rob 1986; Anton and Yao 1987; Laffont and Tirole 1993). *The common finding in these multi-agent compensation schemes is that the buyer lowers prices through compensation schemes based on multi-agent relative performance schemes such as contests and tournaments.*

In situations where model changes may require retooling after the contract is awarded, buyers often prefer multiple sources anyway. Bargaining power of the buyer ex ante as a monopsonist is eroded when a chosen supplier make dedicated investments, resulting in an ex post bilateral monopoly, as other suppliers depart from the supply base. If investment is fully salvageable there is no wasted reliance and suppliers may re-enter sourcing business at will, reducing incentives to multi source. Common uncertainty that makes yardstick competition relevant in this example is the common unsalvageable investment that causes wasted reliance if there is breach of contract (Katz 1996).[5] These considerations drive the actual use of contracts in several industries.

7.5 Examples of strategic sourcing contracts

Transaction cost economics distinguishes between classical, neoclassical, and relational contracting in business exchanges where internalization via vertical integration is unavailable or unattractive. For instance, Williamson describes relational contracting as (Williamson 1986; p.105):

"The fiction of discreteness is fully displaced as the relation takes on the properties of 'a minisociety with a vast array of norms beyond those centered on the exchange and its immediate processes.' By contrast with the neoclassical system, where the reference-point for effecting adaptations remains the original agreement, the reference-point under a truly relational approach is the 'entire relation as it has developed ..."

While attempting to distinguish the contexts of the two, the neoclassical variety of contracts include royalties, fees, expenses, profit sharing, and the like; in contrast, joint ownership and alliances, are akin to relational contracting. Neoclassical contracts are typified by the Uniform Commercial Code (UCC) and the Second Restatement of Contracts, but do not encompass all consensual relationships. In relational contracts short term self interest needs to be subordinated to long term self interest (Feinman 2000; Macneil 2000).[6] However, a distinct classification of contracts into neoclassical and relational is fraught with confusion.

Today, relational contracting is accommodated within the framework of neoclassical law. An increase in relationship contracting would imply higher perceived importance of (neoclassical) contract agreements as well. Some specific aspects of transactions will be more easily anticipated and these can be cast into contract agreements. The importance of so doing will rise if other aspects of the transaction are increasingly complex. As transactions become recurrent and less discrete, the more important it is to remove ambiguity where possible through contract agreements. Williamson identifies a source of transaction costs to be the dynamic nature of economies. In general, advantages of sourcing alliances in dynamic markets would help to reduce otherwise high transaction costs. Inability to foresee contingencies in contracting would call for increased emphasis on relational contracting. This is especially true since repeated transactions are anticipated for growing markets, where distribution volumes would increase in scope and scale. Increase in these forms of transaction costs adds to the value of sourcing alliances, and through its mediating role, adds to importance of neoclassical contract agreements (see also Nordberg, Campbell and Verbeke 1996). Learning, commitment and reputation are aspects that link neoclassical contracts to relational contracts. The new economy or the internet age is proliferating situations of contractual incompleteness. Absence of comprehensive laws governing international e-commerce; poor arbitration of web sales disputes across borders; and information asymmetries of a variety of kinds characterize the environment today. In such situations, increase commitment will increase the value of cross-border sourcing alliances and, through its mediating role, that of contract agreements. Exhibit 7.3 summarizes the need to expand the perspective on contracts.

The view that emerges is summed up in the quote:

"Contract, we now know, is complex and subjective and synthetic in every sense of those terms. The debate, rather, is over the proper nature of *contract law*.

All contracts are relational, complex and subjective." (quoted in Macneil 2000; p.877).

	Complete contracts	Relationships
Knowledge	Best for known technologies and performance variables.	Unknown technologies that affect how actions lead to outcomes; a high influence of random events.
Reward	Based on measurable target prices, profits and gains to trade.	Based on long term security, value creation and capture, usually only qualitatively assessed.
Uncertainty	Fully characterized asymmetric or symmetric information on actions and random events.	Shared uncertainty and information communication, but unknown dimensions of actions and random events.
Incentives	Contracts are designed for performance incentives.	Relationships evolve for eventual devolution of asset ownership and property rights.
Innovation	High, frequent, and short product life cycles.	Medium, infrequent, and long product life cycles.
Oppurtunity costs	Cost of lost vendor business over single time period due to committed resources.	Costs of lost business at various stages of the relationship, and lost opportunities to create value.
Investments	Clearly identified and recovered by vendors, or included in final price as vendor productivity effort costs.	Sunk costs and leads to specificity of assets, and barriers to exit.
Cooperation	Based on commitment and self enforcement, or third party intervention	Based on reputation, goodwill and network or market perceptions.
Conflict	Disruption of transaction, and beach.	Escalation process for resolution and episodic nature of conflict.

Exhibit 7.3: A comparison of competitive markets and relationship contracts for dimensions of tradeoffs. A comparison and contrast between complete contracts and relationships is revealing of strengths and weaknesses of these complementary approaches. *Source: After Seshadri and Mishra (2004).*

Capacity Reservation Contracts: Suppliers in manufacturing industries have an option to sell capacity in (i) the open (spot) market and (ii) through pre-negotiated contracts with buyers (Grey, Olavson and Shi 2002). In the former, competitive market pressures will determine pricing; in the latter relationship contracting will come into play especially when capacity expansion comes into consideration where unverifiability is endemic.

While different approaches are called for in these two instances, there is a degree of interplay between transactional and relational contracts that is the focus of our interest. We believe that aspects such as search and selling cost associated with booking and selling capacity in the open market would (and should) influence the suppliers' pricing strategies and capacity allocation (Hazra, Mahadevan and Seshadri 2004).

In high-tech manufacturing a proposed contract is a reservation fee paid by the supplier that would be deducted at the time the customer places an order. This mechanism enables the supplier to plan capacity expansion (Jin and Wu 2001). In a *pay-to-delay* capacity reservation the buyer undertakes an obligation to buy at least $y < z$ units of capacity at a lower cost. Reserved capacity is typically *take-or-pay*, i.e. even if the buyer does not fully utilize reserved capacity it pays. Further, the buyer can procure additional capacity up to a maximum of z-y units later at a higher cost (Brown and Lee 1997). Automobile manufacturers contract capacity in advance with trucking firms for a lower-than-market cost; and display elements of a relationship approach (Henig, Gerchak and Pyke 1997). A similar contract mechanism is where a supplier offers a portion of its capacity in advance at a cost lower than the market. For additional capacity, the buyer pays at market price (Serel, Dada and Moskowitz 2001). Other work models information asymmetry issues in contracts and assesses the value of information to the suppliers in setting the price for the contract (Corbett and Tang 1998).

The import of these contracting mechanisms is that they benchmark long-term adjustments against markets. While the contract itself is the governance mode, contract elements may be subject to bid. For instance, among other terms, discount from the spot market price may be bid; percent of capacity reserved may be bid; or settlement for buying less than the booked amount may be bid. Varieties of contracts include quantity flexibility, deductible reservation, back-up agreements, buy-back, pay-to-delay, and take-or-pay. For instance, buy back agreements are useful for procuring goods with finite shelf life, whereas quantity flexibility is useful during periods of high demand uncertainty. Deductible reservation and take-or-pay contracts are often employed in high-tech manufacturing enabling suppliers to invest in specific capacity. What these variants tell us is that the buyer can shop around for the right mix of elements in longer-term contract. Key inputs to overcome verifiability problems are facilitated by introducing markets into the relational approach. In sum, there exists not only a market for suppliers within the supply chain, but also a market for contract types.

Sourcing in Supply Chains: There is no one firm or entity that is actually making decisions for the entire chain, and information asymmetries and uncertainties will continue to affect individual firms in the chain differently. Therefore, sourcing strategies must seek to match *risks and returns to individual firms* in the supply chain to obtain best results, and account for self-interest that affects efficiency of outcomes. In other words, contracts must account for propensity to gaming the supply chain.

Collaboration between suppliers and buyers is growing in response to the need for innovation, investment and incentives on the one hand and rising demand and supply side risks on the other. While collaboration is necessary in modern sourcing, there is inherent competition between alternate partners in a multi-sourcing world. In addition, complexity of sourcing arrangements often requires multiple contracts between the same two partners, for separate agreements. For instance, development and manufacture contracts with the same suppliers may require two-stage contracting (Laffont and Tirole, 1990; Seshadri, Chatterjee and Lilien, 1991; Seshadri, 1995).

Sourcing agreements are transactional when they are governed by short-lived arms length contracts of the classical kind with provision for third-party intervention, such as court judgments. Some sourcing agreements are transactional in nature since items procured are commodities or since all contingencies in the agreement can be anticipated easily and written into contracts. Other agreements are incentive contracts that apportion the financial burden of risk and must be self-enforcing, and based on verifiable outcomes. These outcomes must substitute other perhaps more relevant ones, as parties would find it prohibitively expensive to verify such outcomes, unobservable actions, and asymmetric information on capabilities. Paradoxically, a greater ability of buyers and sellers to contract in a transactional mode for routine portions of sourcing allows them to develop more complex relational contracting agreements with the same partners based on trust. Collateral contracting is an example of such thinking (Macneil, 1974). A rationale for this is that violation of trust can now be punished through the contract on a separate sourcing, giving each partner a greater degree of confidence that trust will not be violated. When buyers are unable to commit to long-term contracts and production learning is possible, dual sourcing contracts reduce the two period repeated contract costs (Klotz and Chatterjee 1995). Relationships-contracts impose new burdens among agents in multiple sourcing arrangements.

Software Services Industry: Transactions in current software services industry are typified by four dominant structures applied at each tier of the supply chain: (a) time and material based contracts employing persons with specific skill for specific tasks; (b) fixed price contracts with incentive fees for specific project engagements, with clearly defined incentives for service level agreements (SLAs) and final deliverables; (c) relational engagements with ongoing deliverables[7]; and (d) technological product alliances as platforms for product-specific customizations. Longer-term exchanges link episodes at the relationship level, and link contracts at the supra-contract level. The incomplete contracts approach is a possible foundation to interpret outsourcing or insourcing decisions for information products (Brynjolfsson, 1994). Large overruns are frequent, and these generally incomplete contracts are often renegotiated. The initial contract has a bearing on whether the service provider's share of overrun is high (for a fixed price contract) or low (for a time and materials contract) (Banerjee and Duflo, 2000).

The literature applying the contracts and relationship approach to software markets is limited; what are available are experiential cases, white papers, and methodological approach notes with limited or no research support. Available evidence indicates that generic technical skills (e.g. Java, C++, SQL, etc.) are traded discretely as commodities, while specialized solutions such as enterprise application integration, networking solutions and business performance solutions, etc., follow a long-term relational approach (Lee, Trauth and Farwell 1995). Engagements themselves require multiple skill sets. Generic but diverse skills are bundled together for a unique skill assortment by a special engagement.

IT firms that focus on outsourcing business develop long-term relationships with clients. As an outcome of program management effort, buyers and sellers can specify the longer-term relational contract. This includes a broad specification of terms of reference for specific classes of activities. The program management approach requires open-ended discussions with buyers, on partnering possibilities, scenario planning, and project development. Individual projects are determined within these terms of reference. Market contracts would be entirely transactional in nature and have rigid price-performance tradeoffs. There is a transactional character that develops here. In the course of delivery there will be need for third parties to come on board and write market contracts. For instance, in most large BPO exercises, the systems integration component is heavily dependent on third parties and bid contracts. Project management which would spell out the degree of off-shoring, degree of on-site testing, handover protocols, etc. will require expertise in delivery, and the interface between buyer and seller must bring closure to many of the specific activities that will be invoiced and paid. Exhibit 7.4 provides an illustration of the contracts map in IT Services.

The structure would distinguish between strategic and systematic or operational considerations in outsourcing, and lead to a design on the transactional – relational continuum, as in Exhibit 7.4. Project management is based on relatively simple linear relationships within activities and tasks, using a large number of substitutable resources. Program management is focused on handling multiple programs with limited and non-substitutable resources (e.g. software development and biomedical research in a bioinformatics program). Internal or project-integrated agents hired by BPO suppliers must follow contractual or agency mechanisms that overcome adverse selection and moral hazard problems efficiently. The interface of such efficient management of third party dealings with the longer-term relationship is the responsibility of both sides.

7.6 Conclusion

Incentives in sourcing are not automatic and information barriers limit the ability of buyers to directly reward suppliers for cost management. Risks are central to such situations and risk attitudes complicate contract design. Buyers attempt to manage risk through its assessment, allocation, and indirect reward for

effort that reduces risks. Incentive-risk tradeoffs change with contract forms. We describe several standard ways contracts deal with costs and cost control effort. These forms are fixed price, cost reimbursement, cost plus incentive fee, incentive contracts, shared savings and yardstick contracts. Applications of sourcing contracts illustrate the burden of maintaining relationships that contracts must bear in their role as a governance mode.

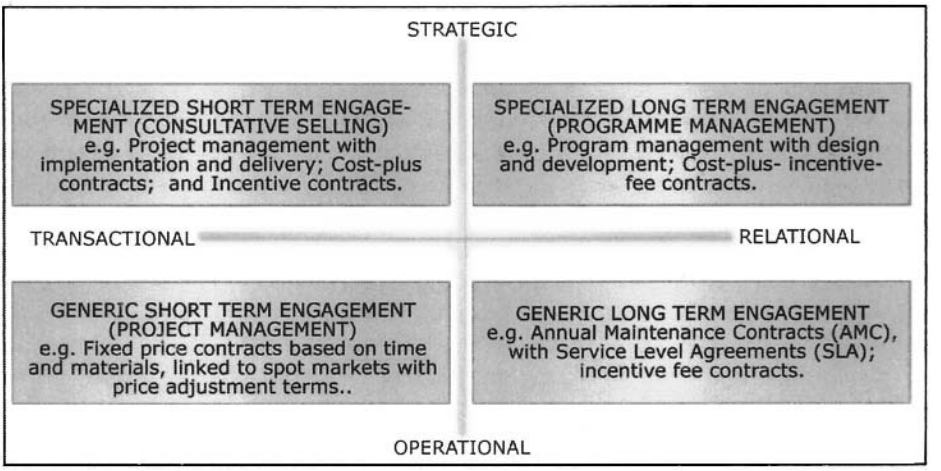


Exhibit 7.4: The IT Services Contract map. The type of contract determines the form of the contract. The IT services contract form involve (inter alia) fixed price, cost-plus, and incentive contracts. *Source: After Seshadri and Mishra (2004).*

Apart from limitations imposed by risky contracts the supply base has constraints that limit the ability of the buyer to achieve its objectives. Variation in efficiency of suppliers in the supply base and their unknown opportunity costs from multi-market or spot market alternatives impose additional information barriers. The next chapter identifies the issues in source selection and describes processes aimed at overcoming these barriers.

8: Source selection

8.0 Introduction

A supply base includes good deal of variation in supplier characteristics. Sourcing strategies must account for the buyer's inability to identify specific suppliers' efficiencies and alternatives. This chapter deals with the principles of supplier selection processes from the perspective of information available to buyers regarding its supply base. Selection processes determine participants of a robust sourcing strategy. A key question we address is: What selection processes allow credible elicitation of sourcing information? A chief advantage of a reverse auction or bidding mechanism is its clear focus on the information revelation aspect, a prerequisite for impartial selection processes based on performance objectives. Simply put, auctions are mechanisms to introduce risk in situations of competition in order to effect price discovery. Other sourcing criteria, such as diversity in the supplier base, are consistent with use of reverse auctions, and transparency in sourcing accompanies use of auctions and bidding. What are options available for source selection, and what policies are best? The chapter classifies the variety of selection criteria, auction and award types, and process options, and clarifies fundamental principles behind the optimal auction.

8.1 Source selection process

While a major consideration is price, what other selection criteria do buyers apply when screening potential suppliers? Differences among suppliers may be a desirable characteristic of the supply base. A buyer may be responsible for as many as 50 suppliers, who differ on geographical, product, capacity, size and assortment characteristics. For instance, a company may have contracts with private businesses, brokers, traders from agricultural markets, monopolies and governments (Hohner, Rich, Ng, Reid, Davenport, Kalagnanam, Ho and An 2003).

The selection competition begins with specification of requirements, bill of quantities, request for information, or request for quotation. At various stages of development of the selection competition these formats are exchanged between buyer and sellers to develop the final format for the offer and exchange. The buyer's primary concern here is to employ a process that will allow it to elicit the

right information in the right detail to make a choice between competing sellers. The seller's primary concern is to achieve its desired returns or profits while maximizing its chance of selection. The source selection process may be straightforward or complex. What are the essential component features of the selection process? The selection process must accomplish two things: one, identification of likely suppliers; and second, determination of a target payment to suppliers.

A typical process is as follows. The buyer develops its requirements in a preliminary fashion, including design elements, quantities and estimates, leading to a bill of quantities (BoQ) or bill of materials (BoM). The buyer then informs suppliers on its list about these requirements, while keeping all its own cost and pricing estimates and uncertainties private and confidential, and seeks information from suppliers to further specify requirements, refine estimates and pre-qualify suppliers. This phase is called the request for information (RFI). The supplier's reply to this RFI with varying degrees of responsiveness, and the buyer then consolidates all available information on suppliers and the project. The buyer processes information with analytic models or heuristics to qualify suppliers; and it makes some changes in program requirements. Responses provide a picture of supply base capability, as well as market and contract conditions that enable the buyer to settle on the appropriate bid-contract design and award mechanism. Details are provided to qualified suppliers in the form of a tender document called the request for proposal (RFP) or request for quotation (RFQ).[1] Suppliers make their entry or participation decision, develop detailed quotes and offers, and submit their response to this RFQ. Usually there are two packages in their submission: a technical and a commercial bid. The buyer schedules its formal evaluation on submitted bids based on RFQ terms and conditions. Most source selection processes follow these steps, with trivial variations.

If the buyer has a lot of experience with certain types of procurements, or if the sourcing is a straight rebuy, it may short circuit development of a new BoQ, or bypass a protracted RFI stage. It would then rely directly on a previously developed RFQ for its current sourcing need. A viable database and retrieval system is valuable for such rapid re-sourcing activities. Even new buys would benefit vastly from an efficient database management system for sourcing designs, where supplier information and RFQ details can be efficiently retrieved and updated.

Suppliers have a chance to provide information in RFQ development as part of the selection process. The RFI stage allows suppliers to present new technologies, changes in capacity or investment information, and improvements in engineered designs for consideration in requirements development. This feedback prior to freezing the RFQ is invaluable for both buyer and seller in assessing risks and rewards of sourcing relationships in a dynamic context. The response to the final RFQ takes the process to formal evaluation.

8.2 Bids and evaluations

The buyer uses the process to great advantage in a formal evaluation. Importance of clear evaluation criteria cannot be understated. Quality of the offerings depends on how well suppliers understand weights the buyer gives to their bid components. Awards can differ widely on several evaluation criteria.

Buyer bid evaluation: A primary decision the buyer must make is to select an award mechanism. An award mechanism is a set of rules that will achieve two ends. First, the rules determine which of the sellers will be selected as suppliers; next, the rules determine what their compensation will be or how it will be arrived at. Rules that determine selection have two aspects: a technical review of sellers' bid offers, and an economic or commercial review.

The technical review is normally made by a panel of experts and demarcates the range of acceptable specifications, design, performance, and quality. This review selects a subset from among potential sellers and quite often eliminates the worst quarter of bidders. The buyer needs to derive a preference ranking or rating for technical bids. Often the buyer does this by a two-step measurement process. First, the buyer assigns a relative importance weights to the technical attribute or category of work and deliverables. Next, the buyer assigns a rating for each supplier's bid reflecting the quality of the technical dimension or category. A straightforward weighted average for supplier rating using these two measurements is possible. The resulting index evaluates the supplier's technical bid and allows a comparison between differing technical specifications. Weights and rating decisions are not revealed to vendors, and is a matter of great interest and intelligence-seeking behavior on the part of strategic vendors. The buyer may also strategically reveal some pertinent measurement scale information where it can improve vendors' bid specifications. With this part of the process completed, the buyer can finally pass or fail suppliers' technical bids prior to moving on to the economic evaluation phase.

If no bid passes the technical evaluation, the award process has run into trouble. Competitive solutions are unlikely to work and the buyer would need to enter into sole sourcing or vendor development arrangements. This is why a protracted phase of request for information is often necessary to develop mutually acceptable specifications and technical standards for a viable selection competition among vendors.

Assuming that more than one bid has passed the technical evaluation, qualified vendors may be considered strategic sellers. Bidders who succeed in passing the technical review proceed to the next phase of economic bid evaluation. If the technical bid package and economic bid package have been invited simultaneously, the failed bidders have their economic bid packages returned to them unopened after the technical review. The economic review is based on a conversion of contracted commercial terms and prices to a monetary equivalent called target cost or overall bid price. Formulae used for this

conversion to a common monetary unit are usually well known to all parties, and so bids can be considered to be price bids.

Finally the buyer needs to develop a method to trade off price (economic) and non-price (technical) evaluations of vendors who passed the technical evaluation. For this, the buyer must decide on the relative importance of price and non-price dimensions, and suitably weight indexes of each for an overall weighted preference rating of the suppliers' combined technical and economic bid. Conversion of the non-price index to a monetary equivalent is a difficult choice. The buyer may have to choose an appropriate conversion basis. Interpretation of this monetary equivalent is the buyer's utility for non-price attributes of the supplier's technical bid. Utility is the buyer's preference expressed in monetary terms, or the buyer's willingness to pay for technical features. This is traded off against price actually bid by the supplier in its commercial or economic bid. Once this is done the buyer has translated the many possible price and non-price attributes to a single index. It is therefore possible for the buyer to arrive at the best bids from its consolidated point of view. Exhibit 8.1 illustrates a numerical example of this process.

*Bid utilities:*The utility of a vendor's bid for the buyer is simply its preference on some scale. Applying a rigorous and formal evaluation process, many attributes of quality and price in a source selection competition can be represented by a single buyer utility equivalent, as in Exhibit 8.1. Scales of measurement in the process described are cardinal scales, and allow relative comparisons of supplier bids on the preference index. The advantage of the approach is that it allows analysis of how each category contributes to the buyer's utility.

As in Exhibit 8.1, the buyer utility is normalized at 100 for supplier 1, and the cardinal properties of the scale allow the difference of 70 units with utility from supplier 2. Relative importance of a category of non-price attribute times its rating for a supplier times monetary equivalent conversion is its overall monetary contribution to the technical bid's index for the supplier. Therefore this product represents utility of the attribute to the buyer in monetary terms. A unit increase in the supplier rating along the category will translate into an incremental monetary amount the buyer will be willing to pay. This incremental amount is marginal utility of the non-price attribute. By definition marginal utility to the buyer is the price. This approach is a convenient way to translate various non-price attributes into their marginal utilities for analytical purposes.

How does it help to know marginal utility to the buyer of a non-price attribute? The supplier would potentially be interested in learning this information. If a supplier knows marginal utility of each non-price category for the buyer, the appropriate pricing strategy for each element of its bid becomes that much easier. Moreover, when the supplier has cost data on its non-price attributes and can determine costs of raising its rating by one unit on the scale, gross profit contribution from increasing its ratings can be determined. This knowledge of profit contribution of quality helps the supplier optimize its technical bid, by choosing the level of quality to offer in its non-price attributes.

More effort should be spent on those attributes where marginal utility is higher. In this manner the supplier can also determine overall profit contribution of its non-price technical quote.

Non-price Attribute	(a) Relative Importance Weight: 0=no importance; 100=all important.	(b) Rating Scale: 1= worst; 50 = best.		(c) =(a) X (b) /100 Weighted IndexContribution: 0 = Least; 50 = Most.	
		Supplier 1	Supplier 2	Supplier 1	Supplier 2
Category 1	10	20	19	2.00	1.90
Category 2	15	25	22	3.75	3.30
...	...	...	...	...	...
Category k	24	15	30	3.60	7.20
	Sum = 100	Weighted Sum (non-price) Index =		33.00	42.50
Monetary Equivalent = 60 ($ '000 per index point)				1,980	2,550
Price Bid ($ '000)				2,000	2,500
Composite Index (of Price & Non-price attributes) ($ '000)				-20	+50
Buyer Utility				100	170

Exhibit 8.1: The buyer's technical bid evaluation index. Attributes of the technical bid in the RFQ are assigned relative category importance weights. The vendors' technical bids are consolidated in the table, and its favorability for each category is measured on a rating scale. A weighted sum index of non-price attributes completes the technical bid evaluation. According to the evaluation, Supplier 1 has overbid by $20,000 (=1,980 – 2,000); and Supplier 2 has underbid by $50,000 (= 2,550 –2,500). Clearly, Supplier 2 is providing better value.

Though not easy, it is possible to use past evidence on selection to determine unstated buyer preferences. Suppliers can use conjoint analysis methods that relate published bid rankings to multiple dimensions of supplier offerings. This technique reveals true weights the buyer ascribes to price versus quality, and various dimensions within these two categories. Information on latent preference weights reduces the supplier's selection risk and leads to more competitive bids.

8.3 Selection risk

Risk is such a central part of the selection process that it must be quantified. What is the impact of risk on the twin aspects of identification of suppliers and determination of target payments? Mapping of supplier insurance requirements to risk adjusted payments is possible through utility analysis of monetary rewards under uncertainty. Uncertainty of winning a competitively bid award itself leads to a risk adjustment of required payments. Therefore, the selection process must account for risk attitudes of suppliers and risk adjustment of targets in selection.

Buyers seek to avoid selection risks when they can. A lot depends on how buyers frame the selection situation. Some likely alternatives to framing are historical break-even, expected value, guaranteed outcome, and so on. The level of loss associated with the worst outcome and the corresponding regret level with supply choices will reasonably affect buyer risk tolerance. Whether or not a buyer would entertain new suppliers will depend on the framing of selection risks. The degree of split purchase would also depend similar considerations (Puto, Patton and King 1985).[2] Can sourcing strategy provide guidance on how the buyer should frame the decision? A normative approach would help relieve the burden of risk perception from the individual buying executive by formalizing it into the firm's sourcing strategy. For instance, one such strategy is the yardstick contract that allows split buys with the provision that the buyer will make comparisons between suppliers for future business allocations.

The yardstick contract discussed earlier introduced the idea of comparisons among already selected suppliers (see §7.4). The risk in such a comparison arises from relative compensation, with a larger compensation for the supplier with the better performance, leading to an incentive for better performance. Moreover, suppliers compete away their rents from private information on common costs. Can this relative comparison risk be pushed for further incentives? In the extreme, a relative comparison that awards nothing to losers and everything to winners is the standard competitively bid award. There is selection information the buyer needs from vendors for which relative comparisons from reverse auctions are crucial.

Information rents and risk: Vendors have private information on their endowments or valuations, such as technological competence and cost characteristics or profitability and opportunity costs. This private "type" information distinguishes one vendor from another. Clearly, the buyer prefers to establish a sourcing relationship or sourcing contract with better type suppliers. What is a better type? For a commodity purchase it could be a lower cost supplier, or one with more excess capacity to book, or one with a higher productivity. In most cases a supplier would be itself able to tell its type on some scale or score that a buyer may choose to make public and determine its own type or valuation. However, vendors may not truthfully reveal this information to the buyer. The vendor's type will therefore not be apparent unless the buyer institutes a formal process that requires vendors to make some claims in a credible fashion.

The formal process that accomplishes this must involve risk in order to provide the vendor the right incentives to reveal their type. This process leads to a selection competition where some of the vendors may be selected as suppliers and others may be rejected. Selection risk arises from a relative comparison of vendors' claims or offers and criteria that the buyer applies to sort offers or vendors into preference rankings. The selection competition that results is none other than a bidding competition or a reverse auction, and offers or claims are called bids or tenders. Selection risk is major tool in the buyer's repertoire of risk-incentive mechanisms.

Investment and risk: A major reason to introduce selection risk is to encourage vendor investment. Buyers are dependent on sellers when they invest in long term arrangements for information exchange, customized supplies, and retooling based on supplier specifications. Sellers are dependent on buyer commitments when they make dedicated investments in capacity based on expectations of buyer demand. Independent Research and development (R&D) costs and bid and proposal expense (B&P) can amount to almost 5 percent of general and administrative costs (G&A) in government sourcing (Fishner 1989; pp. 80-81).[3] In either case, long term investments are made with uncertainties on the relationship's future (Bensaou and Anderson 1999).

There are benefits to forward contracts, where the buyers and sellers share information on demand prior to investments. The parties fix prices, and make negotiated settlements in advance based on available information on marginal costs and value of investments. Long term contracts also succeed in apportioning risk associated with price uncertainties in spot markets. There is a heavy reliance on an arbitrage framework that balances anticipated spot market price, contract price, and value of the contract. Can competitive auctions determine the balance without use of arbitrage methods? If so, this would certainly reduce the burden for management.

One example is from take-or-pay contracts that run for fifteen years or more as forward contracts – the buyer commits to pay for a certain quantity whether or not it uses it. Natural gas contracts are of this variety. What is the minimum long-term quantity to be so committed for a level of investment in capacity? Equilibrium prices are influenced by capacity investments leading to a strategic situation. Auctions enable an estimate of the tradeoff between (a) anticipated spot market prices that necessarily have to be above operating costs and investment capital costs (b) loss of bargaining power once investment is made leading to downward bias in anticipated spot market prices. Of course, in a perfectly competitive market, spot market price and forward contract price will be the same. The problem is an extension to stochastic demand of the capacity constrained contract (Parsons 1989).[4]

Risks of selection differ with market institutions, and provide differing incentives for selection enhancing strategies. Incentives for investment in cost reduction are of primary interest. The issue is important when vendors must make unrecoverable investment prior to learning results of the selection competition.

The type of auction will influence investment in cost reduction. The first price auction is expected to become more competitive and therefore investment is more likely to be lost; the second price auction is more efficient when such investments are possible. Why is this so? In a symmetric case, all firms invest the same and post investment symmetry is maintained, leading to a revenue equivalence in auction types. However, in the asymmetric case the first price auction leads to strategic effects, whereas the second price auction leads to no strategic effects. The intuition resides in the fact that for second price auctions firms' equilibrium bids are independent of other opponents' costs (Arozamena and Cantillon 2004).[5]

Take an initial scenario where all bidders are exactly the same. For such a supply base, vendors are initially symmetric and homogenous bidders, so initial investment itself is a way of determining their own costs. Then the second price auction leads to the socially efficient level of investment. The winning bidder is the one who asymmetrically invests the efficient amount to get the lowest cost, and all other bidders invest nothing. As it is second price, the seller gets no gain from this investment equilibrium, although it is most efficient for the supply base. The buyer therefore prefers the less efficient outcome when all vendors invest, although vendors in the supply base do not. The first price auction induces this less efficient symmetric investment. Using a mixed equilibrium initially homogenous vendors randomize for a symmetric investment strategy, leading to homogenous expected costs. The seller captures all benefit from the lower winning bid as it is a first price award (King, Welling and McAfee 1992). Why is this so? When the winner is guaranteed to recover all its investments as the buyer pays the externality it exerts through investment, it invests the efficient amount. When the winner loses its investment with some probability it will invest randomly to create some information rents for itself, but this will be less than the earlier efficient investment. Clearly, once such an award scenario has occurred vendors are no longer homogenous going into the next auction and the buyer would no longer prefer the first price award. Randomized investments create an investment distribution for vendors that now makes them non homogenous. As the investment distribution comes from the symmetric investment strategy it is a common distribution. This scenario presages the standard symmetric private values reverse auction model.[6]

A recent development in our understanding of investments and selection risk is from analyses of asymmetric auctions (Lebrun 1996, 1999; Maskin and Riley 1996, 2002). The theory is in early stages, and explicit solutions for equilibrium bids even for first price auctions are not available. Common results for two bidders do not carry over to more than two bidders. The direct effect of an investment by one firm is to make it more efficient, and shift its own cost distribution. *Ex ante* payoff is therefore improved. The strategic effect takes into account the aggressive shift of all opponents and this reduces net payoff. In some cases this strategic effect can swamp the direct effect of investments leading to a net negative effect for the firm. An implication is that a supply base may gain by

being less efficient. These results in theory depend on whether investment is observable by opponents prior to bidding.

The preclusion of strategic effects may be why buyers could prefer second price auctions. The socially optimal outcome is that which minimizes cost realizations among bidders; i.e., of expected value of second lowest bid. Investment itself may be an outcome of other supplier activities, such as (a) winning a prior auction in a series of linked auctions where learning, experience and production costs are the links; (b) sequential entry where capability development for repeated auctions is an investment. In such cases a clear preference is indicated for second price auctions (a) as promoting healthier investments and competition; (b) as socially optimal.[7]

The two conditions for leaders to invest more than followers, resulting in their further dominance are higher the initial competitiveness of opponents, less the marginal value of the firm's investments; and higher one's own competitiveness higher the marginal value of one's investment. Under such conditions an initial asymmetry may be propagated by further investments. Horizontal supply base conflict due to asymmetry caused by sourcing processes themselves could intensify the vertical conflicts of price discovery.

8.4 Reverse auctions and price discovery

Source selection requires buyers to undertake formal processing of supplier offers, and commit to declared evaluation procedures. Suppliers adjust their strategies accordingly, and take into account potential risk of rejection and consequent loss of investment. What alternatives are there to reverse auctions in proceeding with price discovery once this stage of the selection process is reached? We examine negotiation and price discrimination approaches as alternatives.

Bidding and auctions are formal agency selection processes where agents are governed by rules for bid submission and evaluation, under clearly specified award mechanisms. To clarify the terminology, it is useful to note that an auction is where the bid taker is seller; and a reverse auction or bidding competition is where the bid taker is buyer. If the seller owns the offering that is being priced, the process is a reverse auction or *bidding,* and the low price wins; and if the buyer owns the offering that is being priced the process is called *auctioning,* and the high price wins. Therefore concepts from auctions and bidding are identical with the appropriate reversal of roles for the bid taker.

Negotiations versus bidding: Once the vendor conforms to rules for submission and technical and economic bid evaluation its selection or rejection as a supplier will depend on its bid's utility to the buyer. The single resulting top-level evaluation dimension allows use of negotiations and bargaining processes, as well as straightforward reverse auctions or bidding competitions for source selection and target setting.[8] Negotiations are bilateral, with a sole supplier and a

buyer, where private information on reserve prices may be communicated through either take-it-or-leave-it one shot offers or a complex process of offer and counter offer referred to as the "negotiation dance".

Buyers use competitive bidding to prevent implicit or explicit coordination of bid prices.The natural tendency for suppliers is to restrict competition, as they would be better off with fewer rivals. It is likely that incumbent suppliers will have marshaled arguments in favor of negotiations over bidding competitions based on their offers, in the hope of a sole supplier environment. A usual argument is that an earlier bidding competition had already been held and a winning supplier as the incumbent would be best to deal with, even it means the buyer employs a take-it-or-leave-it reserve price for the current sourcing. This after all is the optimal mechanism design even for a new sourcing with a given number of bidders. Therefore, suppliers and some buyers often suggest negotiations for selection and target setting as viable alternatives to bidding competitions.

But are negotiations with a fixed number of bidders preferable when a reverse auction can be held? An answer is available from the theory of optimal auctions interpreted from the marginal expense perspective. The buyer's expected minimum marginal expense is lower when a follow-up auction with an additional bidder can be used over a take-it-or-leave-it negotiation following a bidding process. A reverse auction where an additional bidder is likely to participate is always preferable for the bid taker, as expected price is always lowered when an auction is used (Bulow and Klemperer 1996). Therefore, a buyer would eventually be better off with a reverse auction in the final stage of price discovery, despite bilateral negotiations with all likely bidders prior to this final selection. For this final stage of price discovery we should concentrate on the reverse auction approach to selection of suppliers and setting of targets, rather than on negotiations.

What advances the process that makes reverse actions preferable? An increase in the number of bidders makes the auction mechanism more attractive, whereas more complex procurements find negotiations more attractive. Flawed designs and project plans encourage adverse selection in competitive bidding. The bidder who identifies the flaw will underbid the rest knowing that renegotiation will become necessary as the project unfolds. Mis-specification and incomplete designs also result in renegotiations, and bidders find fixed price auction mechanism unable to deal with such incompleteness (Bajari, McMillan and Tadelis 2002).[9]

Co-ordination with repeated communications is better handled with negotiations. The request for information phase of an auction is an opportunity for such communication, however. Privacy needs require that those who are aware of designs are kept to a minimum. Reputation induced rankings are better handled through informal selection methods. Our view: auctions are best used in conjunction with unavoidable negotiations. That which can be contracted is subjected to auctions, and successful bidders can negotiate the rest. Also, in multi

sourcing negotiations will be extraordinarily complex as concessions to one supplier will be demanded by others. In situations where some work or a design phase can help freeze specifications, the cost plus contract leading to a contest is likely to help. Reverse auction mechanisms with two phase contracts as discussed in later chapters can be devised for this. Additional cost from such two stage bidding processes is weighed against additional costs inevitable in negotiations.

Do negotiations improve when alliances are in place? Alliances are more likely when the sourcing requirement is of strategic importance; the supply base has very small numbers of suppliers; program complexity is high; and there is a great deal of uncertainty. Alliances are not always possible. Even when possible almost half of all alliances fail, and supplier relationships go the same way. Competitive pressures on the OEM make it violate all these alliances and relationships. Performance measurement in alliances is difficult but possible (Pyke and Johnson 2002).[10]

What if additional bidders, or all bidders are of the same type? When all sellers are of one homogenous type and all buyers are of another homogenous type is bargaining preferable to auctions? If the ratio of buyers to sellers happens to increase, buyers are worse off under both negotiations and auctions. However, the portion of surplus for buyers is better under auctions when some conditions hold. These conditions are reinforced when buyers increase relative to sellers, and retain a bigger share of the pie. In fact, both buyers and sellers find auctions preferable in these circumstances. Self reinforcement of preferences for auctions, therefore, makes auctions better than negotiations for repeated exchanges (Lu and McAfee 1996).

Price discrimination: A buyer may be tempted to use price discrimination approaches where it does not commit to an award price mechanism in advance. For instance, it can set a reserve price that differs for each supplier based on their response to the RFQ; or they may re-package portions of the buy and prorate prices. These approaches could be self-defeating, as suppliers would strategically modify their bids when the buyer does not pre-commit to an award pricing method. Analyses of share auctions or split buys similar to where the buyer reserves such award price discrimination rights support this argument (Anton and Yao 1989). The auction mechanism allows the bid taker to discriminate among bidders by pre-committing to a method for setting an award price. Bidders use the award mechanism that the bid taker can commit to in advance to self-select bid price for the product for sale. The auction improves the probability of selecting the bidder who values the object the most. Ability to discriminate between buyers who would not voluntarily or credibly reveal their willingness to pay, with a commitment to an award mechanism, is a major achievement of the auction.[11]

In an analogous fashion, ability of bidding competitions and reverse auctions to distinguish between vendors who are willing to perform a contract or sell an object at a lower cost than others is a cost discrimination advantage. The buyer can then select the most efficient vendors as suppliers. The supplier uses the reverse auction mechanism to communicate hidden information on its reserve

price in a credible fashion through application of auction design concepts. They tradeoff is between selection risk and rents in either case, and so we will use the terms auction, reverse auction and bidding interchangeably, and allow the context to make the meaning clear.

Another advantage of auctions relative to negotiations or other procedures is that it discourages collusion (Rasmusen 2001; p. 329). The burgeoning literature on auctions and bidding owes its phenomenal growth to major theoretical advances, coupled with creation of new markets. Surveys of the auctions and bidding literature have periodically been necessary to synthesize the richness (Stark and Rothkopf 1979; Engelbrecht-Wiggans 1980; McAfee and McMillan 1987; Rothkopf and Harstad 1994; Klemperer 1999). These surveys still provide excellent introductions to the scope, subtleties, and promise of the vast and growing literature on auction theory and practice (see Krishna 2002). Procurement borrows heavily from auctions in supplier selection phases, often running through the entire program.

8.5 Types of auctions

Once we convince ourselves to employ the power of auctions in sourcing, we are immediately confronted with a vast choice. There are several ways of classifying auctions. The typology may be in terms of how bidders value their payoffs from the auction; or in terms of how the bid taker sets the rules of the award. The literature from auction and bidding theory has distinguished between two extremes. One extreme is where bidders (vendors) have private values (costs) that are independent of other bidder's costs, though they may have identical distributions (IPV, or independent private values). The second assumes the contrary, that a vendor's costs are common across vendors and that each differs merely in their estimation of common cost and is termed the common value model (CV, for common value). Empirical studies of actual auctions show strong evidence of both private and common values underlying the cost structure (Paarsch 1992; Giliberto and Varaiya 1989; Hong and Shum 2002).[12] A combination of independent and common values, or a CV-IPV structure to costs, is also observed in some contractual settings especially where yardstick or relative compensation is used. Common values could naturally arise from common input prices, which may be uncertain in the future; and private values arise from private technologies with varying efficiencies in converting inputs into products and services. A statistical structure to bidding models that allows quantification of several insights from the mix of CV-IPV costs is the affiliated values (AV) approach.

Common values (CV): A big problem when cost is common across various vendors is that of errors in cost estimation on their part. Vendors often under-bid deliberately when price escalation is possible in the post award period. However, this is rare in fixed price contracts and often under bidding is due to genuine

errors in estimation of uncertain costs. When several rivals estimate a common value the lowest estimate is likely to be biased; and the common value is likely to be closer to the statistical mean of the estimates. In fact, a situation described as *"the winner's curse"* may occur when the seller that wins the contract finds that it has won precisely because it has underestimated its costs relative to all others, and bid too low to earn a profit (Capen, Clapp and Campbell 1971).[13] The well-documented winner's curse phenomenon occurs more frequently than not. Knowing this likelihood of under-pricing, bidders will be less aggressive in equilibrium and bid more cautiously. Several authors have analyzed common values models where equilibrium bids are padded to account for the winner's curse effect. However, despite these several attempts to model the problem and pad bids to cover errors in estimation, sellers still suffer the winner's curse. Experimental work has demonstrated that the winner's curse phenomenon is persistent across auction forms, market size and subject population (Dyer, Kagel and Levin 1989; Kagel and Levin 1993; Hong and Shum 2002). Myopic bidders who cannot anticipate the winner's curse seem to be the rule rather than the exception for objects that are bid for resale. Increases in the number of bidders leads to an intensification in the winner's curse as the likelihood of mis-estimation by the winner increases (Matthews 2002). Consequent drop in aggressiveness may overshadow competitive effects of higher numbers of bidders and lead to an increase in costs (see Bulow and Klemperer 1996 for example). In CV situations it is unclear which form of auction rules will yield lower costs.

Affiliated values (AV): Rarely have authors proposed specific models that include common values (CV) as well as independent private values (IPV) features (notable exceptions are Harrison and March 1984 and Harrison 1990). A unique formulation is the affiliated values model that displays properties of both CV and IPV models, yet is not constrained to be either. An affiliated vales model includes error in cost estimates, but also includes private cost differences. The specific statistical definition of affiliation is technical, but intuitively affiliation means that the likelihood of extremes of the distribution of private cost estimates changes based on the realization of a particular bidder's cost estimate (Milgrom and Weber 1982). Therefore, a bidder who estimates a high private cost for itself finds it likely that higher costs are more likely for all other rivals as well.

Can we improve on our prescriptions for auction rules? Auction rules that yield lowest costs are the open cry descending bidding competition (the English reverse auction) followed by the second price sealed bid competition (Vickrey reverse auction). Information revealed in the former allows mitigation of the winner's curse effect and bidders can be more aggressive. Can the bid taker further help this process? When the bid taker has information on costs it is best policy to reveal honestly the bid taker information to all bidders, as this information reduces the winner's curse and will lead to lowest costs for sourcing. Increase in the number of bidders also leads to a higher chance that the winning bidders may have misestimated costs.

The AV model allows further insights into auction rules and the role of information than the CV model and is clearly more accurate in its assumptions. Can accuracy introduced by the IPV structure of costs be improved upon? Many procurements bid are weighted toward the IPV costs and perhaps insights from a pure IPV model of bidding will guide sourcing.

Independent private values (IPV): The winner's curse effect does not exist for independent private values. The bidder has a private value for the contract that is independent from all other bidders' private values. Uncertainties about one's own private value may be stochastically common before the value is observed, in the sense that there may be identical probability distributions from which the supplier's value or private cost is drawn. However, each supplier's realization or draw is independent. When there is no information to be learnt about other bidder's costs from one's own draw, we have a pure private values model. The IPV model may often apply when sourcing is international as widely differing economies will lead to private factor costs as well among suppliers. Moreover, when suppliers base their bids on opportunity costs rather than direct production cost, the IPV assumptions are more likely to hold. An argument for opportunity cost based pricing is presented in §9.6. Opportunity costs are dependent on local market conditions rather than on production technologies and would vary independently, particularly in sourcing across borders.

Can the IPV model provide bid takers further quantification of preferences in their reverse auction rules? Once the winner's curse is avoided, there is no specific preference for any of the four popular auction forms – the ascending or descending open cry (English and Dutch auctions) or the first- or second-price sealed bid (first-price or Vickrey auctions). They all yield the same expected sourcing price. The buyer may however prefer the Vickrey auction as this is efficient in that it allocates the object to the one who values it the most, even when bidders do not have identical cost distribution (are not symmetric). See §9.6 for further discussion on differences between efficiency and optimality. Many other powerful results follow from the IPV approach due to its wide, though approximate, applicability and the now well understood modifications to results arising from winner's curse effects.[14] Perhaps the most well known finding is that of revenue equivalence, discussed in §8.9.

The bidding or auction rules that yield best results in an expected sense for bid takers is a central concern when designing or evaluating a bidding competition. The rules may have to do with whether the offering will be divided among multiple bidders, or whether the single best bidder will win the award; and it may be in terms of how award price is related to bids. Information that is made public during the course of the auction will affect bidder strategies, and therefore sealed bid rules sometimes lead to different outcomes from open-cry rules. With seemingly endless variations in rules to fix award price, guidance that screens our attention to particular award mechanisms is very welcome. Logic for so restricting considerations is not obvious and flows from a key insight known as the revelation principle.

8.6 The revelation principle

The varieties of bidding rules possible are made analytically simple by the *revelation principle* (due to Myerson 1981). Simply put, the revelation principle states that an auction mechanism that induces agents to truthfully reveal their private information can be found, and such a mechanism corresponds to and yields the same outcomes as any arbitrary auction mechanism. The best example of the revelation principle at work is the Vickrey second price auction. The ability to restrict our attention to a few direct mechanisms, such as the Vickrey auction, is a great advantage.

This is a powerful principle for theoretical auction design, since it restricts search for optimal auctions to incentive compatible auctions that induce truthful revelation. Practically speaking, all auctions could be prefaced with a process that transforms the supplier's reserve price, using the selfsame formula for the equilibrium bid that the supplier would use, to yield the bid otherwise obtained from the supplier. The buyer should commit to this award price determination process. Then the supplier has no incentive to deviate from a truthful revelation knowing that this award price process will precede any target cost evaluation.[15]

Incentive compatible mechanisms: How can this truthful revelation be brought about? The answer lies in the bidder's realization that the bid taker could pre-commit to basing its award on the analytical calculation of the optimal bid on behalf of the supplier, if the supplier were to reveal its private information. In that case the supplier has no incentive to deceive the bid taker, as that would be tantamount to deceiving itself. A mechanism that induces the truthful revelation of private valuations in equilibrium is said to be incentive compatible. It is necessary is for the Principal (buyer or bid taker) to calculate equilibrium strategies for the arbitrary auction given any particular realization of the seller's private information, and commit to the sellers that it would itself compute their allocations and equivalent payoffs if the seller were to reveal their private information. Direct reporting of private valuations coupled with incentive compatible considerations allow bid takers to examine a subset of all auctions to determine which is optimal.

Auction design: With this ability to screen arbitrary award mechanisms, auction design can now be legitimately attempted. Armed with the revelation principle for direct reporting of valuations, and incentive compatible constraints, the bid taker seeks to find the auction mechanism that suits its needs best. With no further constraints but that bidders be individually rational in that they get no less than their valuations from the auction, and that the number of bidders is known, the solution to the standard optimal auction design problem is well known (for example, Harris and Raviv 1981; Myerson 1981; Riley and Samuelson 1981). Another well known result provides assurance on optimality across award types as it deals with payments the buyer expects to make.

8.7 The Revenue Equivalence Theorem (RET)

A major concern of a buyer is its expected purchase price, or the amount it expects to spend on acquisition through the award. We had identified acquisition cost control to be an important sourcing objective, and guidance on this count will help buyer confidence in the selected award mechanism. A cornerstone result in auction theory is that of revenue equivalence (or acquisition cost equivalence, in the case of reverse auctions). The underlying assumptions apply in a wide variety of situations, which cover most application scenarios in this book. Key assumptions behind RET are (a) stochastic symmetry of bidders; (b) risk neutrality or expected utility bidding behavior; and (c) independence of private value information (IPV). A simple expression of RET is that expected cost to the bid taker from any auction is expected expense on the winning bid, given the contract is awarded to the lowest cost bidder, and the highest cost bidder expects zero payment.

Revenue equivalence of second price and first price auctions holds in multi sourcing situations as well. A common multi-sourcing situation is where each of the vendors has desire or capacity for a single unit contract. The buyer awards say k unit contracts and that there are more than k vendors. Each vendor has a privately known opportunity cost for the contract independently estimated from a probability distribution, which forms the basis for its equilibrium bidding strategy (the IPV model). Consider the set of award mechanisms as bidding games where in equilibrium (1) the vendor who has the highest opportunity cost which corresponds to the bid taker's reserve price, receives an expected payment of zero; and (2) vendors who have the k-lowest opportunity costs are certain to get the contract. In this multi-sourcing situation what can we claim about acquisition cost from revenue equivalence? The revenue equivalence theorem (RET) argues that all award mechanisms that satisfy (1) and (2) yield the same expected cost for the bid taker; and (2) the expected cost is k-times the expected award price, which is none other than the expected opportunity cost of the $(k+1)th$ -lowest bidder (for other equivalent statements see, for example, Milgrom and Weber 1982, Theorem 0; or Klemperer 1999).

Risk neutral bidders: RET is useful for a variety of situations where the above assumptions hold; and so the award mechanism can be either an ascending auction or descending auction. Expected acquisition cost for the buyer is the same whether the buyer uses the lowest rejected sealed bid or the highest accepted sealed bid award. Revenue equivalence holds when the number of bidders is known and the number of suppliers is fixed (as noted first by Vickrey 1961). The intuition follows from the observation that bidding strategies, conditioned on private information alone, will yield equivalent expectations when evaluated prior to the supplier realizations from its private values distributions (further details on these and other bidding-related issues are available in reviews by Engelbrecht-

Wiggans 1980; and Klemperer 1999; and numerous references therein). But open cry auctions reveal more information than sealed bid auctions, and there may be a departure from revenue equivalence in situations where risk is particularly important to bidders.

Risk averse bidders and utility equivalence: When does RET fail to hold? Common situations are when (a) the auction type determines entry of bidders, and predetermined number of bidders is not a valid assumption; (b) when collusion is possible in an implicit way through open availability of information as the auction proceeds; and (c) when vendors are risk averse. Not all auctions are equal in an expected revenue sense when these conditions prevail (Klemperer 2002; Lewis and Sappington 1997). Why should auctions not be revenue equivalent with risk averse bidders? Bidders would perceive different risks with different auction forms. For example, a risk averse bidder would find the ascending open reverse auction less risky than a sealed bid reverse auction. The selection risk premium it would associate with the former would be lower, which would lead it to shave its bid more for the sealed bid reverse auction. The buyer therefore gets a lower expected acquisition cost for a fixed price sealed bid auction with risk averse bidders. So how should RET be modified in evaluating alternative designs with risk averse bidders? One way to address the problem is the standard expected utility approach, where private type information for symmetric bidders is interpreted as utility rather than costs. RET then holds for expected utility paid to vendors, as a utility equivalence theorem (UET). Further structure to the vendor's utility for profits helps to determine different risk premium amounts with which suppliers pad their bids under different auction types, and induce departure from RET. With the effect of differing risk premiums, the bid taker can be shown to get lower prices for Dutch or first price reverse auctions that correspond to open-cry awards relative to English or second price reverse auctions that correspond to sealed bid awards (Harris and Raviv 1981).[16] The intuition is simplified with the argument that UET holds for risk averse bidders, but different risk premiums are associated with the different award types. Open cry auctions are more aggressive as risk premiums are smaller with revealed bidder information. These robust results and the simplicity of auctions contribute to their widespread use.

8.8 Ubiquity of auctions

Auctions are used in so many varieties of transactions that parties often consider them as substitutes to spot markets. Differences between auctions that we observe on the surface are far less significant than their similarities. Seemingly disparate procedures that describe art auctions, flower auctions, treasury auctions and internet auctions are explained by a few basic characteristic combination of properties. Objectives of the auctions determine properties it should have. Typical objectives are of two types: (1) efficiency objectives where bidders who value the object the most will receive the object up for auction; and

(2) optimality objectives where the bid taker gets the best results from the auction. These objectives are not easy to ensure either individually or simultaneously, as information is asymmetric or private in many cases. The ubiquity of auctions reflects the ubiquity of these objectives under uncertain and incomplete information situations.

The perception of fairness in supplier selection and price determination is a widely felt need. The basis for continuity in supply relationships is perceived fairness in allocation of business opportunity among likely suppliers. What are the roots of the perception of unbiased and fair allocations? Commitment to clear and simple rules that govern allocation and pricing is a cornerstone of this perception. The ubiquity of auctions is therefore due in part to their clarity and simplicity as mechanisms or bodies of rules for allocation and pricing.

The flexibility of procedures that achieve the desired objective is a distinct advantage of auctions. Business rules that govern auctions are flexible as they may be decided and announced by the bid taker independently of most legal restrictions that govern spot markets. Public agencies may be governed by specific acquisition norms that are more stringent than private agencies, and yet auctions allow sourcing markets for both public and private goods. A demonstrable absence of favoritism is often the only inflexible requirement in auction procedure. Along with other requirements this can be readily assured with some simple rules.

8.9 Auction Rules

While the revelation principle and revenue equivalence screen the vast variety of auctions we need to consider, there are still relevant choices for the buyer in the auction rules employed. Utility equivalence rather than revenue equivalence, for instance, associate differing risk premiums with the rules. The rich variety of auctions observed in practice exhibits some stylized properties. Quite remarkably, these properties are traceable to just a few key dimensions.

Open / sealed: Open progressive bidding competitions, or open-cry auctions, are those in which the buyer announces a bid level and invites bidders to submit progressively lower or higher bids. Open cry auctions or reverse auctions may have different procedures in how prices ascend or descend and what bidders are allowed to do in response to reveal their private information. In the English reverse auction the bidder is free to revise its bid downward as many times as it pleases. When no further downward revisions are made, the award goes to the lowest bidder. In the Dutch reverse auction price is announced and continuously increases. The first bidder who stops the bid taker gets the award at that price.

When multiple sourcing is needed there must be some variation in how the bidder is allowed to respond. Open exit and concealed exit are two such variations. The open-exit auction is a descending open auction where the exiting bidder publicly announces its departure as price falls below its reserve price (cost

for performing the contract). All other sellers as well as the buyer can observe open exit for a given seller. Concealed exit refers to the rule where a seller may exit the remaining portion of the multi-source reverse auction, but only the buyer is aware of the given seller's exit. Other sellers are unaware of how many sellers have exited. Open bid competitions are commonly encountered in business markets.

In sealed bid competitions, sellers submit bids with no knowledge of others' bids; bids are simultaneous and a seller is permitted only a single bid. Sealed bid competitions which award the contract at the highest accepted bid give rise to identical bidding strategies for sellers as the progressively ascending competition type that awards the unit sourcing contract to lowest bidders at the price at which the last supplier enters the pool of suppliers (Vickrey 1961, 1962; Ortega-Reichert 1968).

Ascending / descending: Strategic equivalence among sealed bid auctions and open cry auctions are useful comparisons. It is known that when buyers and sellers are risk neutral, symmetric, and cost values are independently realized from a commonly known cost dispersion, an open progressive auction type has a strategic equivalent among the sealed bid competition types. For instance, sealed bid auction rules that award the unit contract to lowest k bidders at the uniform lowest rejected $k+1$ *th* bid price and the open exit English descending bid competition type that awards the contract to the remaining k bidders at the price at which the last $k+1$ *th* bidder has departed from the competition have identical equilibrium strategies for sellers.

The open bidding approach may not in some instances be convenient to adopt, though it is often used. A problem is the difficulty in organizing a viable venue for the auction, though internet auctions are solving this problem. The lowest rejected sealed bid auction has the drawback that sellers may not be willing to believe the buyer's announced value of the lowest rejected bid.[17] The advantage of the open exit English reverse auction is the additional information available to bidders on the reserve price of the exiting bidders, which is not available under the usual descending (Dutch) auction. When used with multiple sourcing, the discriminatory price sealed bid (or "totem pole") reverse auction is strategically equivalent to an English concealed exit reverse auction (we discuss and use the totem pole auction in Chapter 15). The rules for price discovery have similarly few dimensions.

8.10 Award pricing mechanisms

The open or sealed, ascending or descending dimensions still leave us with the task of setting award price. The buyer can use information from all the bids, from only winning bids, or from only one bid to set the award price. The way the award price relates to bids will certainly influence bidding strategy.

Uniform / discriminatory: Common award pricing rules are uniform price or discriminatory price. The uniform price awards the unit contract at a single uniform price for all selected vendors. The discriminatory price does not. The uniform price may use highest accepted bid (called the first uniform price, or first price) or the lowest rejected bid (called the second price) as the award price. The discriminatory award price may also use the selected vendors bid (first discriminatory price) or the selected vendor's next lowest bidder's price (second discriminatory price) for the award price to that particular bidder. The multiple source uniform second price auction finds applications in various situations. The multiple source discriminatory second price reverse auction is less frequently discussed. This bidding process sets each selected supplier's award price at the next lowest bid price. Therefore this discriminatory price reverse auction may be termed the "totem pole" auction. These combinations have various advantages for multiple sourcing.

As noted earlier, revenue equivalence does not carry through in all sourcing situations. When bidders are risk averse and have IPV costs the discriminatory price award results in a lower acquisition cost than the uniform price. Risk premiums are lower and bidding is more aggressive, so even when utility equivalence holds acquisition price falls. When bidders are risk neutral and the IPV of costs fails to hold and suppliers have affiliated values, the uniform price award generally results in a lower expected acquisition cost than the discriminatory price award (see Weber 1983).

Accepted/ rejected bid price: Take for instance the lowest rejected uniform price reverse auction (also commonly called the second price or Vickrey reverse auction). Let us consider dual sourcing. The award price is therefore the third lowest bid. This is the fee the buyer has to pay the next best trading partner if it were to substitute the two selected. Therefore, this is the buyer's opportunity cost which conveniently emerges from the bidding competition itself. The pooled fee for dual sourcing a pair of unit contracts is set at twice this buyer opportunity cost as a "second price," and is often encountered in bidding analyses. We will see that the Vickrey auction is incentive compatible, and truthful revelation is a dominant bidding strategy. Its appeal is its analytical simplicity and its ability to induce truthful bids from both suppliers, in the sense of revelation of the true private reserve fee for bidder entry. The "incentive compatibility" property of this pricing approach is that bidders have the right incentive to truthfully reveal their reserve cost, private information critical to their bidding strategy, in order to reduce selection risk, while making all their profit on the higher "second price" set at the rejected bid level. In fact, the revelation bid is the dominant bid strategy for *uniform lowest rejected bid pricing* for any number of selected suppliers, not just for two as we consider here (dual source second price utility bids are used in Chapter 18).

Another rationale for this revelation with the uniform second price is that the rejected bidder sets the award price. The selected bidder or bidders cannot collude to change award price. Other ways to set prices are at the bid price of the second

best bid (uniformly) or at each bid fee for each bidder (discriminatory). Each of these will lead to different bid strategies, more complicated than our second price revelation bid strategy. However, the buyer will be indifferent between these methods since they lead to the same expected fee. Recall that we learnt this interesting theoretical result as "revenue equivalence" of bid pricing mechanisms (a term used as early as Vickrey 1961). The intuition for revenue equivalence stems from the distribution of the rejected bidder private (opportunity) costs being independent of the auction mechanism. Therefore, the same identical total acquisition cost expectations result, when expectations are taken over the prior distribution. Price discovery depends also on the way the unit contract can be divided.

8.11 Objects for auction:

Often sourcing activity may be split into equivalent portions and each awarded to different bidders. This is the usual unit contract version of multiple sourcing. The unit contract is the object that suppliers bid for in the multiple object reverse auction (Weber 1983 provides several results for multi-object auctions).

Single /multiple: There is usually some restriction that determines whether the object may be split or divided, or whether it should be procured as a single whole entity. For instance a contract to supply an architectural design may not be possible to divide among two suppliers, but a contract to build a highway may be split for different stretches of highway among multiple suppliers. For the most part we consider objects that may be arbitrarily divided, with each of the divisions being procured from different suppliers. When divisions are equal, the contract is split into equal portions that are called the "unit contract".

The unit rate contract is a variety of object that may be split into items, each with estimated quantities and unit rates. Vendors bid rates individually for each item. Sometimes vendors are free to combine several items into bundled categories. They may also allow discounts on selected items based on a quantity schedule, rather than offer a fixed unit price rate. These variations lead to different incentives under information asymmetries as they offer opportunities for information rents. See §9.8 for unit price contract price inflation incentives in pre- and post-award case. The buyer may often prefer bundled pricing in order to be rid of such gaming, although bundling may reduce its ability to run combinatorial auctions.

Combinatorial auctions allow buyers to source strategically from many suppliers based on their rates for specific items that exhibit synergies (Hohner *et al* 2003). Bid takers invite bids for combinations or sets of items where aggregation or other marketing, logistics, or production synergies may lead to better prices when procured from the same supplier. Bids may be for overlapping lots of items, and are not for mutually exclusive sets only. Justification for combinatorial auctions across several items are: (1) it allows sharing of business

in order to maintain long term relationships with multiple suppliers across the supply pool; (2) it provides a rationale for savings from auctions that does not rely on "squeezing supplier margins" but on synergies; and (3) it reduces the buyer's time spent on price negotiations.

Unit / variable quantity: For certain types of procurements the number of unit contracts procured will be determined prior to the competition; then the quantity purchased is fixed and invariant. Capacity or quantity required is simply the sum of all unit contracts. This is usually the case since other larger considerations than those thrown up by the reverse auction determine the buyer's quantity requirements. In these situations the general finding is that multiple source reverse auctions lead to higher prices than single source reverse auctions. When the buyer can vary the quantity procured, as well as make output allocation across contract winners after bids are received, the finding is that multiple sourcing dominates single sourcing. Deterministic costs of production would take away some incentives the buyer may have for using multiple sourcing as a way to extract information rents from suppliers. Despite this possibility there exists a general preference for multiple sourcing among buyers (Dasgupta and Spulber 1990).

Single / sequential: Sequential auctions reveal information from earlier stages that influence bidder behavior in later stages. The buyer's announcements of sale and award price from a given round get to be known before the next round of bidding. A buyer can better manage its demands on supplier capacity through use of sequential auctions, but the impact on price is not necessarily favorable. Many fixed costs get charged as general and administrative (G&A) in the earlier contract period and therefore should not be charged to the same cost objectives again in later contracts, but would continue to be charged.

A sequential approach to sourcing should go beyond sequential auctions. Staged sequence of selection and performance reveals new tradeoffs between incentives and risks in selection and performance. Analyses of selection and performance incentives in multi-agent scenarios had proceeded independently of each other in most studies. Exceptions are a variety of dual source scenarios such as a single-stage bidding model with entry costs and risk averse bidders (Klotz and Chatterjee 1995); a multi-stage approach of repeated auctions with learning (Raffel and Chatterjee 1989); and a multi-stage bid-contest model where both suppliers are appointed at the very start of the innovation/ production phase (Seshadri 1995). Focusing on single auctions or exclusively on either the selection issue or on the performance incentive issue in multiple sourcing had lead to contradictory findings on the net value of multiple sourcing. Multi-stage or sequential auction approaches reveal hidden advantages of multiple sourcing (these scenarios are discussed more fully in Chapter 18). Insights into price discovery characteristics of auctions could be sharpened by linking auctions to the more traditional marginal analysis.

8.12 Marginal Revenue and Marginal Expense (Advanced topic)

The revenue equivalence result is so remarkable that it warrants a closer look. Why does revenue equivalence of such disparate award types hold? An alternate explanation comes from marginal analysis. The auction fetches the bid taker a marginal revenue for each item sold; and conversely the reverse auction has an associated marginal expense as the expense for a unit contract awarded. The bid taker attempts to maximize the sum total of marginal revenues for the auction; and conversely it minimizes the sum total of marginal expenses for the reverse auction. In the reverse auction, marginal expense is related to equilibrium bidding strategy in an important way. The supplier's equilibrium bid is its best marginal cost, or the lowest it can bid given its private information and still expect to be awarded the contract.[18] The bid taker's total sourcing cost is the sum total of selected suppliers' marginal costs. This explains RET. Expected acquisition cost for the bid taker is independent of award type or any one bidder's private costs, since all suppliers have the same expected marginal costs prior to learning their private costs. It depends only on the distribution of private costs, which is the same, for the symmetric bidders case, regardless of auction type, despite actual bids, or marginal costs conditional on privately learned cost being different (Bulow and Roberts 1989).[19]

Exhibit 8.2 provides a graphical explanation. The winning bidder reports a cost; the buyer translates the cost report to a marginal expense, as it knows the cost distribution of this bidder. If the immediately next higher marginal expense is M2, how high could the winning bidder have reported and still won the award? The answer determines the award price and is P, inverse of M2 on the winning bidder's marginal expense curve. This is the best price the buyer could expect. For symmetric bidders all cost distributions are identical, with the same F(.) and f(.). Then the lowest valuation or cost bidder is also the best marginal expense bidder. However, for asymmetric vendors distributions are different and the lowest cost bidder may not be the best marginal expense bidder. Thus the key intuition we must grasp in the asymmetric reverse auction is that the optimal auction does not necessarily award the contract to the lowest cost bidder. With some probability, the award goes to another higher cost bidder who has the lower marginal expense curve.

The symmetric bidder's expected price is no different from expected second lowest cost when it is less than the bid taker's reserve acquisition price. If is not less, then expected price is the bid taker's reserve price. This argument links reverse auctions to the monopoly theory of price discrimination, what might be termed third-degree price discrimination.

Here, price paid to the supplier is based on mechanisms to extract information rents from individual suppliers, rather than merely from segments of vendors. The marginal expense interpretation yields the upward sloping supply curve analogy. The bidder's cost or value is analogous to price; and the probability of not

exceeding the value (the cost distribution function) analogous to the quantity supplied at that price. Marginal expense at each value is then the vendor's value with information rent for profit.[20] The analogy leads to the result that the bid takers expected payment is identical to the winning bidder's expected marginal expense, i.e. expected second lowest cost. The arguments here help us answer the next big question.

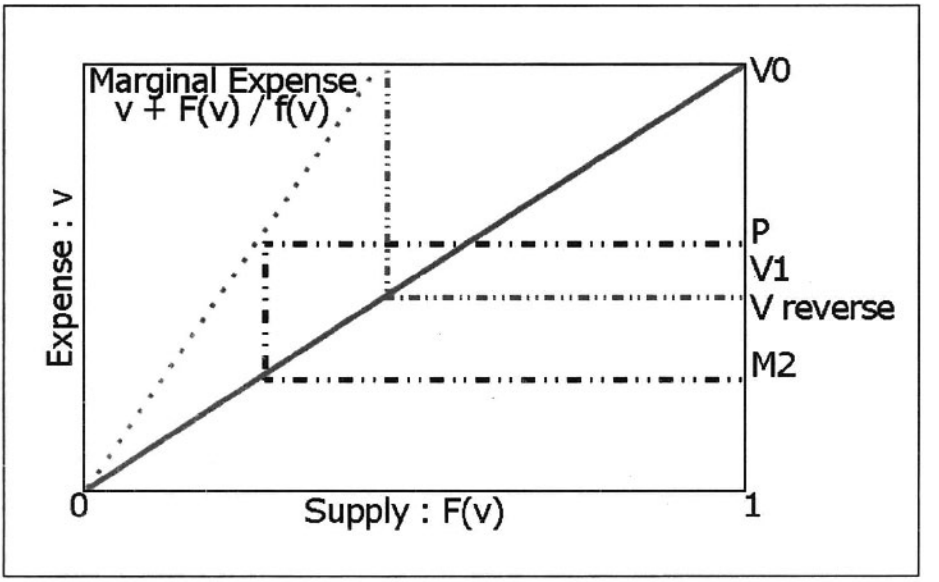


Exhibit 8.2: Marginal expense and optimal reverse auctions. The analogy connects concepts of marginal revenue and expense to auctions and bidding. The information rent is the inverse hazard function, [F(v)/f(v)] where F(v) is the cumulative distribution of private value; and f(v) is its density function. Award price and is P, inverse of M2 on the winning bidder's marginal expense curve. V is the buyer's reserve value; V1 is the bidder's reserve value.

8.13 Optimal Auctions (Advanced topic)

What is the best auction design? When the bid taker has the main objective of minimizing cost, the best auction design to accomplish this has some identifiable constraints. First, the award cannot be directly based on private costs since these would not be known; second, suppliers would be free to bid their optimal strategies; third, suppliers must expect to make more than their reserve prices (Myerson 1981). In other words, constraints for the optimal auction are respectively marginal revenue based awards, supplier individual rationality, and supplier entry or participation.

With these considerations the bid taker can find the optimal auction. To do this it restricts attention to the class of auctions that induce direct truthful

revelation of private cost information. Such a mechanism can always be found which involve only the direct reporting of private values, subject to the above constraints. The key is to find the right incentive to induce truthful revelation. This incentive to a large part is the bid taker's guarantee to compute equilibrium bids on the bidders' behalf based on their reported private value, which it is better situated to do relative to any individual bidder as it additionally has the entire vector of reported valuations. In part, the incentive depends on the bid taker's ability to commit to the optimal auction, and abstain from misuse of truthful revelations and refrain from ex post drops in its reserve costs.

The bid taker uses direct reporting of the vector of valuations to determine two functions: (1) a probability that the particular bidder is selected, which may be just zero or unity representing selection or rejection; and (2) a payment to each bidder, which may be zero if not selected and some specified amount if selected.

This direct incentive compatible reverse auction is a constrained optimization problem that is readily solved. As all other reverse auctions forms may be represented by a corresponding incentive compatible reverse auction, by applying the revelation principle, the optimal direct incentive compatible auction is optimal across all auction forms. With these considerations the optimal reverse auction can be found to provide the two required functions of probability and payment based on the vector of valuations. The constrained minimization of expected expense based on the valuations bid yields the probability of selection function that allocates the contract to bidders with a probability; and the payment function that determines the expense for each bidder. These functions are as follows:

(1) The bid taker awards the contract to the best marginal expense bidders. However, the probability is less than unity that these bidders get the award. Firstly, the bid takers own reserve valuation must exceed the winning bidder's valuation for the bid taker to reject its option of doing the job itself. Secondly, the bid taker sets a reserve cost strictly below and therefore superceding its own reserve valuation for each bidder (of course, this is the identical across symmetric bidders). This is the corresponding cost where the bidder's marginal expense crosses the bid taker's reserve valuation. Therefore with some positive probability no bidders is selected and the award is not made, even when bidders submit values below the bid taker's reserve valuation. This clearly introduces the possibility of an ex post inefficiency in the optimal auction.

(2) If awarded, the optimal reverse auction sets the price determined by the vector of bids. Winning bidders are awarded a price that is higher than their own valuations. Price is exactly that valuation at which they would cease to be the lowest marginal expense bidders and have lost the award. In other words, this is the bid taker's opportunity cost of awarding to the current winners.

For the symmetric bidder situation there is no apparent difference for the selection function between marginal expense and valuation. But for asymmetric bidder situations, where private costs may be drawn from different cost distributions, there is a clear difference. The bidder with the lower cost distribution may not have the lowest marginal expense; this is cost increased by

the information rent. The disadvantaged bidder with the higher cost distribution reports a cost; but the buyer evaluates it as though it reported a lower cost. How much should the buyer favor the disadvantaged bidder? The optimal factor to reduce the reported cost depends on the relative cost elasticity of the probability functions of the asymmetric bidders (McAfee and Mc Millan 1989).[21]

The optimal auction is therefore inefficient in this second sense, that the buyer may select the higher valuation bidder over a lower valuation bidder in a stochastically asymmetric bidder situation. Clearly, the bid taker should be more concerned about marginal expense than valuation, since the expected acquisition cost is the expected sum total of marginal expenses paid out to the multiple suppliers. This realization links optimal auctions to third degree price discrimination by a monopolist (Bulow and Roberts 1989). In this book we restrict our sourcing designs to the symmetric bidder situation and so we expect the most efficient bidders (read those with the lowest private valuations) will also have the lowest marginal expense as their equilibrium bidding strategy.

The optimal auction among all possible auctions is that which allocates the object to the top marginal revenue bidder. The optimal bidding competition or reverse auction does so to the lowest marginal expense bidder. The more general result is that the optimal mechanism among all possible award mechanism is the optimal auction (Myerson 1981).

The difference between optimality in the sense of revenue maximization or cost minimization, and efficiency is pertinent to the design of auction mechanisms. Efficiency aims to allocate the award to the bidders with the best valuations, and maximize social welfare rather than the surplus to the bid taker. Auction mechanisms with these objectives may not be optimal in the sense discussed earlier, as efficiency criteria may be at odds with optimality criteria for mechanism design (Krishna and Perry 2000).

8.14 Conclusion

The supply base responds strategically to a buyer's source selection criteria, and this offers a new challenge for sourcing strategy. Information shared through tendering processes, while indispensable to supplier selection, is also less than complete. Therefore, the buyer must account for strategic representation of asymmetrically known supplier information and seeks to use mechanisms that introduce appropriate selection risks in order to extract information rents. Particularly important private information held by suppliers is the amount of investment they make in developing competitive bids. Buyers usually employ competitive bidding or reverse auctions, as these are demonstrably best suited for sourcing. General principles from mechanism design, and comparisons with negotiations and price discrimination assure us of this optimality.

The rest of the chapter describes a variety of reverse auction rules and types, and presents the cornerstone results for choice among these reverse auctions such

as the revelation principle for incentive compatible auction design, and revenue equivalence. We discuss options for the buyer on award rules and prices and fundamental aspects of multi object bidding. Lastly we discuss marginal tradeoffs, and the form of the optimal auction.

In the next chapter we next take the perspective of the supply base. Bidders respond to reverse auction award choices by altering their bidding strategies. Objectives related to capacity management and better governance interact with acquisition costs minimization objectives. This is demonstrated by including efficiency in addition to optimality principles. We discuss the importance of the number of bidders who participate from the supply base, the process the bidder goes through in deciding whether to bid, and the benefits of sequential reverse auctions. Our special interest is in the impact of multiple sourcing, and the influence of opportunity costs on bidding behavior.

9: Supplier Strategies

9.0 Introduction

The supply base is not a passive set of vendors with interests in perfect alignment with buyer objectives in selection. This chapter deals with the vendor's strategic perspective on the supplier selection process. How do we expect vendors to react to buyer selection policies? Selection policies generate changes in supplier behaviors that have implications for investments, competition, pricing, and performance. Rival vendors seek to outbid each other, and these changes in supplier behaviors have cascading effects on the nature of selection competition. The key concern for suppliers as well as buyers is: How are bidding strategies affected by award procedures? The chapter considers vendors' primary decision of whether to enter selection competition in the first place, and the implications this has for competitiveness. Finally, we examine vendor responses in the post award phases.

9.1 Bidding strategy

Suppliers intending to compete in a reverse auction need to devise a prescription to choose among a possible set of actions (bids) depending upon how their private reserve price (i.e., costs) estimates turn out. The prescription that relates their bid to their own estimated cost should also inform them on likely bids of their rivals in the reverse auction. A bidding strategy characterizes these prescriptions, and may be based on optimization considerations or on equilibrium considerations.

Naïve bidding: Historically, bidding strategy analyses were aimed at characterizing what the single decision maker who seeks a prescription for itself would bid, without considering what rivals would bid. Some form of expected profit maximization was the sole criterion. The profit from bidding depends on margin at any given cost; higher the margin the higher the profit. Yet, the probability of winning in a competition depends on the likelihood of lowest price. Probability of the win rises with a lower bid price.

The optimal bid is therefore the bid that balances the tradeoff between margins and probability of winning, to yield the best profit in an expected sense. How is this best bid price determined? The bidder starts with the belief that

competitors bid price follows a fixed distribution. Its probability of winning is therefore dependent on all bidders having higher prices than its own bid price. A vendor can use a simple extreme value probability distribution to capture this event's probability density for a given price. As usual, the bidder's expected profit is defined as the margin conditional on a given price times the probability of winning at this price. As the naïve bidding approach seeks to maximize expected profit from bidding, the challenge is reduced to modeling the extreme value distribution of price, and optimizing with respect to this decision variable.

This approach is used widely, and has the advantage of being simple to understand and yet sophisticated in its modeling of extreme value distributions that match empirical data on prices. For fixed price contracts results are deceptively convincing; it is with more complex contracts such as incentive contracts that the naïve approach begins to unravel.

Why equilibrium bidding strategies: Single seller decision optimization strategies, as the naïve bidding approach, can lead to surprisingly counter-intuitive results for incentive contracts. Assume that (a) sellers try to maximize profits by choosing between sourcing business and its alternative; (b) the buyer prefers lower cost targets to greater; (c) the profit rate and sharing rate are fixed prior to bid submission. Efficient suppliers are forced to share profits from cost under-runs with the buyer, so they find it optimal to inflate their bids. Inefficient suppliers share their losses with the buyer, so they find it optimal to underbid. Only when sharing rate is unity are bids unambiguous indicators of the sellers' estimated costs. Divergence between bids and actual costs leads to a (paradoxical) selection rule that prefers the highest bidder (McCall 1970).

An important intuition for understanding this is that the single seller optimized bidding strategy assumed was non strategic and unreasonable. It did not distinguish consider expectations sellers held about how rivals relate their bid prices (target costs) to their private costs (Holt 1979). Sellers are likely to determine their bid partly on the basis of what actions they expect of their competition. The assumption is unreasonable that sellers make offers only to equate their expected utility from receiving the sourcing contract with utility of their alternative profits. Normative analysis requires rational behavior: sellers should consider optimal strategies other bidders will use when they decide what is optimal for their own use. This argument introduces game-theoretic equilibrium analyses of competitive bidding strategies. A bidding strategy for a seller is considered to be an equilibrium strategy if the seller has no incentive to deviate from this strategy when all rival sellers are known to be using their equilibrium strategies. Strategic bidding as opposed to naïve bidding uses equilibrium concepts in some form.

A bidding strategy is a function that relates the firms' privately known reserve price to a bid price. Reserve price is the price, if not exceeded by the award price, at which the seller would withdraw from the competition. For example, in the fixed price contract reserve price could be the firm's estimated contract cost; or opportunity cost; or some combination of the two. In situations where estimated

cost are common value, or lack realistic basis for estimation, private opportunity cost may be a good way of distinguishing bidders. However, if bids are submitted in addition to other ongoing business and capacity is not likely to be committed irrevocable to bid business, then opportunity cost may not be a good basis. The combination of estimated cost and opportunity cost could lead to adverse selection problems of the kind noted above (McCall 1970; Canes 1975; Samuelson 1983).

The solution for these adverse selection problems requires additional bid information on contract parameters, such as bids on sharing rates, to be available to buyers. Multi dimensional bids are necessary and may be invited for special purposes. A schedule of prices for different contract quantities, called step-ladder bids, is possible under multiple source awards. There is reported evidence from defense sourcing data that sellers strategically inflate step-ladder bids for all quantities except that which they find optimal to supply. The practice of splitting the contract equally into unit contracts, one for each supplier, seems to minimize this tendency (Borger and Liao 1988).

Sellers may adopt dissimilar strategies when they bid for sourcing business. Differences arise when certain sellers behave idiosyncratically, perhaps by bidding very low to win a contract and thus become qualified bidders for future contracts. In many sourcing competitions, bidders seek to exploit specific differences between their bids and bids of potential rivals. Such differences of strategic importance arise primarily due to technological differences between sellers. Only free access to technology would serve to limit the strategic importance of technological differences among sellers.

Despite these differences between suppliers, it is a common assumption in bidding analyses that sellers are strategically symmetric (Maskin and Riley 1984 provide a rationale). Symmetric strategies are the unique equilibrium for bidding designs contained in this book. Intuitively, symmetric strategies assume that identical players cannot play different strategies. When sellers assess expectations prior to their decision to bid, symmetric strategies and stochastic equivalence yields identical expected profits for all vendors. Symmetric equilibrium strategies provide a benchmark for expectations in the design of award mechanisms. One instance is strategic behavior in multi agent selection competitions.

9.2 Bidding in multi-agent selection

The two chief types of awards in multiple source selection auctions are identical contract awards as equal fractions of the unit contract, or variable share awards. Unit awards lead more naturally to competitive bidding situations, and each successful bidder is awarded an identical equal unit award. Share awards are more likely to result in collusive bidding strategies depending on vendor's decisions on what it considers its best share.

Competitive bidding: These models analyze sellers' bidding strategies when the auction does not allow for implicit or explicit coordination of bid prices. Competitive bidding is the benchmark situation in auction design. Bidders do not share private information with their rivals. They seek to extract the most information rents they can from the buyer, but base their competitive bids on non-cooperative strategic behavior. This means they cannot make binding agreements or credible agreements based on mutual cooperation; all actions are credible solely due to self- interest.

Collusive bidding: This occurs when suppliers have implicit understandings that increase the size of the pie for the bidders. This situation arises when selected bidders can collectively influence prices they will obtain. For instance, in a share auction, the buyer auctions objects that may be divided into arbitrary shares, which may be bid for as share pricing schedules by vendors. Then the buyer could award shares ex post to suppliers depending on their bids. When all who bid may receive some share of the contract, bids tend to be collusive. A split-award has bidding equilibria that yield the cost minimizing split of the whole award, and simultaneously maximizes the price to the buyer (Anton and Yao 1989). A share auction allows the seller to inflate his bid price for a given fraction of the contract with the expectation that if all others likewise inflate their bids, the fraction of the contract each bidder receives will be the same (Wilson 1979). Share auction bidders are able to influence their award prices while unilaterally raising their bids. Therefore even two bidder situations would lead to collusive equilibrium bids. Suppliers prefer these auctions since their individual profits under collusion will exceed that from competitive bidding, where the winner-take-all situation may prevail.

The general result from either competitive or collusive auction-focused analyses is that multi-agent selection schemes lead to higher average unit prices than single agent selection auctions. The advantage of multi-sourcing must therefore derive from objectives other than purely bid price minimization. In fact, the advantages stem from performance incentives, capacity development, and risk sharing, among other advantages (for a discussion of multi-sourcing advantages see §2.6). Perhaps the advantages will cause supplier costs to fall in the long term.

9.3 Reserve values

How low can the supplier's price conceivably fall? The supplier has its own internal relevant cost structure that affects its estimated cost for any given sourcing. Often costs for the contract depend on a variety of dynamic and uncertain determinants, such as capacity that has been already committed; volatility of direct costs from material consumed in production of the good or service; indirect costs such as factory overhead or administrative expenses that are absorbed into the costing approach of the supplier; and may even depend on opportunity costs which are a special type of reserve price. Estimated production

costs may be the basis for the supplier's bid, or estimated opportunity cost of committing capacity may be the basis for the bid. Reserve price refers to either type of estimated cost that forms the basis of the bid. It simply is the award price below which the supplier would not find it profitable to enter the bidding competition. Clearly, any award price the bidder finds acceptable should exceed this reserve value.

The equilibrium bidding strategy requires that the seller know its own estimated reserve price, and also know the distribution of estimated reserve prices of its rivals in the auction. Stochastic symmetry considerations prior to learning its own cost estimate lead the bidder to the usual assumption of identical cost distributions from which the specific supplier would draw its own cost endowment. The specific draw identifies the supplier's "type" as determined by its cost estimate, but this is private information. While information on competitor's opportunity costs or their likely cost estimates are closely guarded and secret, vendors have both market intelligence and expertise to develop estimates of what those competitive costs are likely to be. There may be differences in economic terms and conditions, such as financial terms and delivery schedules, between vendor bids. Buyers usually translate these differences into their monetary equivalents. For example government buyers sometimes favor local suppliers over foreign suppliers with a 6 percent price differential advantage. Persistent differences between suppliers will cause disadvantaged vendors to depart from active competition before too long. The vendor's actual characteristics – audited costs, estimated cost, and opportunity cost – are independent of any other vendor's characteristics.

When cost distributions are independent as well, the auction is an independent private values auction; otherwise it is either a common value auction or an affiliated values auction. In these latter cases, the buyer is ignorant about values though sellers are better informed, as they observe their own cost estimates and make better estimates of rivals' costs. In all these cases, information asymmetry therefore exists once estimates are known, although there is information symmetry at the start when both buyer and all sellers merely know only cost distributions. Reserve value cost estimates may sometimes be separable into a private values part and a common values part, both of which may be uncertain and unobservable by the buyer.

Reserve utility: In turn, the supplier has a utility associated with its bid. Ability to translate its bid to profit terms, and therefore to utility for profit terms, delivers a great advantage to the supplier. It enables the determination of risk premium required when it bids for risky business. The expected utility approach discussed later relates risk premium, expected utility and expected profit from the bidding competition.[1] Why should the buyer also seek to know the supplier's utility for bid profit? The buyer can determine the risk premium with which a vendor pads its price bid for various risk-incentive tradeoffs from different contract designs. It therefore helps the buyer to design more efficient contracts as well, when various parameters of contracts are subject to bidding competitions.

9.4 Multi-dimensional bids (Advanced topic)

Multi-dimensional bids address a vector of parameters that involve more than a scalar price. A quality or a number of quality dimensions may be involved. Characterization of optimal auctions here is difficult, and results are contradictory (see §9.6). One common form of multidimensional bid involves price and quality. It is often possible to reduce many quality features to a single quality dimension composed of a weighted sum of quality ratings (as in §8.2). The possibly many price dimensions could also be reduced to a single weighted sum or a monetary equivalent. How are the resulting two-dimensional bids of price and quality to be related to bid taker preference score? What is the correspondence of the score to the optimal auction? The optimal auction results may be extended to the case where quality is also considered important in selection and award of the contract, along with bid price.

Consider the parameterized cost distributions auction – the non-symmetric bidders case. The optimal contract is awarded on the basis of the buyer's evaluation of quality and adjusted supplier cost. The difference in monetary value of quality between the winner and its closest rival must exceed difference in adjusted cost between the two bidders. If the difference in adjusted cost is too large, the higher quality bidder may not be the best. The bidder may be able to choose its quality, and then the buyer must not discriminate between bidders – but if quality is exogenous the bid taker uses a discriminatory evaluation. Optimal discrimination depends on the marginal effect of the cost parameter that differentiates bidders. There are two effects that bid takers use to extract information rents by making the auction more competitive: (1) discrimination that favors the lower cost firm; and (2) discrimination that favors the low quality firm (Naegelen 2002).

The scoring rule for evaluating bids reflects discrimination. The second price auction awards the contract to the bidder with the highest score on value of quality less the bid, and at a price set by the highest rejected score. The translation of the highest rejected score to a price is through adjusted cost. The adjustment is the value of quality net of marginal expense to the buyer of the contract. The firm's optimal strategy is to truthfully bid adjusted score, based on both its cost parameter and quality of its product, rather than only on its cost. Compensation is therefore the cost corresponding to the value from the highest marginal expense the winner could have bid without losing the contract.

The procedure is as follows: the bid taker announces the scoring formula for valuing quality and adjusting cost, and bidders can easily figure what their net score will be from the value-adjusted cost formula. Bids are therefore adjusted cost revelations, and the buyer applies its inverse adjusted cost formula on the second highest score to determine the payment. Clearly, there is *ex post* inefficiency when the firm with the best cost does not win the award if its adjusted cost is not low enough.

Opportunity costs of bidding: A different aspect of multi-dimensional bids arises from another dimension of costs relevant to bidding. Opportunity cost is often a consideration in addition to production expense. Capacity utilization drives both. Higher capacity utilization (CU) rate increases opportunity costs of suppliers as less outside business is needed to fill capacity and higher rates can be charged for remaining capacity. A higher CU rate may also increase production costs, due to more indirect production cost allocations thereby reducing its profits. Overall elasticity of unit supply price with capacity utilization is usually less than unity, but positive; a lower CU rate leads to lower per unit prices but not proportionately lower. Because of this empirical reason an incentive compatible reverse auction will be least expensive for the buyer when supplier type is identified by its opportunity costs than its CU.[2] This principle follows from our understanding of Vickrey-Clarke-Groves (VCG) mechanisms.

Sourcing markets are typically those for which the supplier needs dedicated production facilities or skills to prepare technically competitive bids. Once it decides to participate, the vendor often commits design and production capacity that it would use for the specific sourcing (if it were selected as a supplier). The vendor may make irretrievable investments in technology in order to determine state of the art production costs or incur option-type expenses with subcontractors. Often the vendor must guarantee the bid as valid over several months during the evaluation phase. The cost of maintaining commitment free capacity can be significant. Each vendor has to assess its opportunity cost subsequent to a decision to bid. Opportunity cost depends on the supplier's aggressiveness in landing business as well as the industry's volume of business activity. Larger opportunity costs are more likely as industry capacity utilization rises.

Opportunity Costs and VCG Mechanisms: We have seen that auction theory provides powerful results for unidimensional types, such as production cost as a basis. Many of the insights do not readily carry over to multidimensional agent types. Multidimensional types, for instance those with increasing marginal private values for multiple goods (private upward sloping supply curves), are technically difficult to analyze and economic insights are opaque. The optimal auction can be different depending on what type dimension is used as the basis.

Some insights are possible when we add an additional principle of efficiency to the study of optimal auctions and look for policy advice from efficient mechanism design. After all, we need to go beyond optimality principles to choose between optimal auctions based on different type characteristics. Optimal mechanisms and efficient mechanisms are two different things. The first focuses on expense minimization, and the second on social utility or supply base welfare maximization. Many buyers are concerned with both, especially when taking a strategic view of sourcing. An intriguing result is that among the class of efficient mechanisms the award that is expense minimizing is a VCG mechanism. Thus VCG combines the prior and additional criterion of efficiency with optimality.

This combination of principles offers a way to choose the combination of type dimensions that should be used in auction design.

What further insight does this provide for situations when opportunity costs define bidder types in addition to unit contract production costs? Now at least two type dimensions characterize the supply base, and there is a third namely CU that is correlated to both. Let us examine VCG mechanisms more closely for help on which dimension to choose. The VCG is a mechanism that defines two things for the award based on a revelation of the supplier's type vector: an allocation (of the contract) vector, and a payment (supplier compensation) (Krishna and Perry 2000).

Allocation: Allocation in the optimal reverse auction is the award of a single object or unit contract to the highest "priority" or lowest marginal expense bidder rather than the bidder who values the object the most (i.e., lowest production cost or highest profitability bidder). This, however, may not be efficient. With the buyer ceiling price (lower than its own valuation) for the optimal reverse auction, there is a positive probability that the unit contract is not awarded and there would then be unrealized gains from outsourcing – an inefficient outcome for an optimal reverse auction. Even with a sole dimension of production cost, it is clear that greater efficiency for the supply base would result if the contract were always awarded, and if the supplier who made the highest profit got the contract. In the VCG mechanism allocation is to the bidder who values the object the most, as long as the buyer's reserve price is not exceeded.

Payment: The VCG mechanism sets the supplier's excess compensation at the amount of its externality for being included in contracted allocation. Total utility to everyone else in the supply base without the supplier, less total utility to everyone else in the supply base with the supplier included in the allocation is the extent of the supplier's externality. With only the production cost dimension, the externality imposed by a supplier is set by expected price the next best supplier would command when the supplier did not compete.

Generalized VCG mechanisms: This careful examination of the VCG mechanism is necessary for an insight into how multi-dimensional types allow a redefinition of efficiency. The VCG mechanism must be extended as there is not just production cost determined profit for welfare of the supply base, but also opportunity cost. Excess compensation of the VCG mechanism must account for opportunity cost. Compensation to each vendor selected by the efficient incentive compatible mechanism is the externality from inclusion of the vendor less its opportunity cost. A key finding of the generalized VCG is that the optimal type dimension the buyer should look for minimizes welfare to the supply base from a supplier's inclusion less the supplier's opportunity cost. This type dimension also minimizes compensation payout. Then expected utility from compensation for the supplier is just equal to its opportunity cost. Such a supplier would be most reluctant to leave alternate business and enter into the bidding competition for the multiple-sourcing contract. A generalization of the VCG is now possible for the purpose of determining the optimal type basis for efficient mechanisms. The

generalized VCG drops two implicit assumptions of the standard VCG to include opportunity cost. The superceded restrictions of the VCG are:

(a) the opportunity cost of entry is zero, or there is no variation in the alternate individual rationality participation threshold dependent on the supplier's type; and

(b) the excess compensation or externality that the agent imposes is calculated on the basis of its absence from contract allocation, or when its reported type utility for its allocation is zero.

Dropping both of these restrictions contribute to the notion that inclusion as a supplier can increase the supply base compensation due to opportunity costs sacrificed. This generalization allows redefinition of efficiency and brings greater flexibility in selection and price discovery. Flexibility comes from redefining welfare and externality using a different definition of type as the basis.

Recall that a type characteristic that is likely to be correlated to both production cost and opportunity cost is CU. If CU is the chosen basis, then profit alone determines neither compensation nor entry. Now the supplier may impose an externality even when its utility for the contract is zero (it makes no profit), and the bid taker may choose a basis for the externality different from the supplier's entry criterion (its reserve profit).

Optimal basis: When all three, opportunity cost or production cost or CU, could be used for the VCG mechanism basis of supplier type what basis should the bid taker should prefer? The best basis is the type vector that defines the most reluctant supplier. The most reluctant type of supplier is the one with lowest supply base profits excess over its opportunity cost. Then expected payoff to the supplier is no greater than its opportunity cost. This basis for type yields the least payment by the buyer and therefore the best VCG mechanism over all other types that could be used to distinguish suppliers.

The generalized VCG argues that if using opportunity cost as the type to characterize the supplier identifies the most reluctant supplier then opportunity cost is the optimal basis for the buyer to use. Why is this the best basis? The supplier's excess compensation is simply excess profit from the contract over its opportunity cost. The buyer minimizes its expected payout by minimizing the social welfare that all suppliers get (when the supplier is included in selected vendors) over the supplier's opportunity cost. Unless the elasticity of price with CU rate is negative, a lower CU would never yield lower supply base welfare, and this is very unlikely.

Opportunity cost bidding: CU affects opportunity costs much more than production costs. Then opportunity cost is highly variable and production costs do not vary much in the supply base, and the most reluctant supplier generating "type" is none other than opportunity cost. The social welfare of the supply base is clearly minimized when everyone reveals their opportunity costs as their types and the lowest opportunity cost suppliers are selected for unit contracts. In this case, the VCG mechanism that uses opportunity cost as its basis rather than production costs is closest to optimal among the class of efficient mechanisms.[3]

For single object auctions, this argument establishes that the Vickrey auction based on the second best opportunity cost is the optimal and efficient award. When it is reasonable to assume types as opportunity cost (or opportunity utility) then efficient and optimal mechanisms coincide. This happens when production costs are more or less constant. Among all mechanisms that are efficient, incentive compatible and individually rational, the VCG mechanism with types based on opportunity cost minimizes the buyer's expected total compensation.[4]

The simple intuition for these conclusions is that all efficient incentive compatible bidding mechanisms would be expense equivalent except for a constant term; this constant term is minimum if the basis for type is opportunity cost rather than any other type characteristic. In other words, the most reluctant supplier type who has the least to gain from any VCG mechanism should be identified by its opportunity costs.

Capacity constraints: If there were no capacity constraints, the same supplier could supply all objects. No doubt the cost at which additional objects are supplied will rise due to capacity constraints. As an example, for multi object auctions where objects are identical and non complementary, and bidders have increasing marginal valuations or upward sloping supply, the Vickrey reverse auction, a VCG mechanism, minimizes expense among all efficient reverse auctions (that are incentive compatible and individually rational). This is an interesting extension of the sourcing through auctions of single objects to a given supplier to multiple objects to a given supplier, even when the supplier has different production costs for each subsequent object. The Vickrey reverse auction is still best.

On the other hand, why buy from the same supplier? Multi-sourcing is an option when capacity is constrained. Other less efficient suppliers can supply additional objects with a unit contract award for each. The relevant type characteristic is the capacity utilization dependent opportunity cost that varies across the supply base. Chapter 14 develops sourcing design for this scenario. Selling in multi-markets with capacity constraints enhances the importance of opportunity costs in supplier bidding strategies, especially when unit production costs are not highly dispersed.

We next turn our attention from choosing a basis for bidding to the decision whether to bid at all. Like the make-or-buy decision of buyers that determines whether an intermediate goods market demand exists, this decision determines the very existence of intermediate goods market supply.

9.5 Number of bidders

The number of bidders in any competition is a key determinant of its success. The number of potential bidders should not be confused with those who actually submit serious bids. While the decision to enter a bidding competition is central to determining its competitiveness, this decision has been hard to quantify. The

somewhat simple approach is to take the number of bidders as exogenous, or pre-determined by some unknown process, external to the award mechanism. However, this approach may lead to counter-intuitive results, such as empirical findings that suggest increase in number of bidders leads to higher prices (Hong and Shum 2002).[5] It could very well be that more bidders are attracted to more profitable contracts.

The importance of attracting additional bidders can never be overstated. No amount of gain in bargaining power by the bid taker can compensate losing a bidder. Overall negotiations with one's supplier base is less valuable to the sourcing officer than making the acquisition process more attractive to expand the potential supplier base. Moreover, if dropping the reserve price will secure an additional bidder in the competition, it is optimal to do so. The optimal reverse auction should raise the award reserve price to the bid taker's own valuation. The reverse auction with an optimal reserve or ceiling price strictly below the bid taker's valuation is the optimal mechanism to award the contract with a fixed number of bidders, as discussed in §8.15. When entry of bidders is a concern and a fixed number of bidders cannot be taken for granted the bid taker has no use of a reserve price. A fixed entry fee for the auction can replace the reserve price. Information rents that the reserve price helped to extract from the bidder no longer exist when bidders make zero economic rents due to an entry fee condition (McAfee and McMillan 1987; Myerson 1981).[6] It is therefore pointless to set a reserve price in addition to an entry fee. The realistic situation of an entry decision that is affected by award mechanisms can now explain why reserve prices are rarely specified in practical reverse auctions that seek to be optimal.

The "numbers of bidders" logic for eliminating reserve price from the optimal auction is generalized by the marginal expense interpretation of §8.14. The bid taker's expected acquisition cost is the expected marginal expense on the winning bidder. Let's say dropping of reserve price attracts a bidder who may have had a valuation worse than the reserve cut-off but no worse than the bid taker's valuation. Even if the additional bidder has an expected marginal expense equal to the bid taker's valuation, expected minimum marginal expense over all bidders in the reverse auction is improved with the additional bidder. The reverse auction with an additional bidder (with a valuation above the bid taker's) and no reserve price is better than an optimal reverse auction with a reserve price and one less bidder. Clearly, if dropping reserve price to attract a bidder beats the reverse auction with an optimal reserve price with any given number of bidders, it is superior to any other mechanism to award the contract (Bulow and Roberts 1996).

What will attract an additional bidder? A standard but non-behavioral argument for bidder numbers is to assume entry from an infinite pool of potential bidders until the increase in competition whittles profits down to the fixed entry cost resulting in a zero economic profit condition. More realistically, potential bidders are finite, bidders have opportunity costs that differ, and a fixed entry fee is not the only zero economic criterion for entry.

Entry decisions: The decision of a vendor on whether or not to bid is behaviorally somewhat involved. The protracted and expensive process of bidding in response to a request for quotation (RFQ) often results in large sunk costs that are lost for vendors who the buyer rejects. Bid and proposal preparing costs can be 8 percent of total cost input on average. While these may be recovered as G&A expenses when the supplier wins the selection competition, it can be lost when it doesn't (Fishner 1989; p.82). The number of bidders is not usually a fixed and constant quantity, but depends integrally on the sort of competition and profits possible. Sellers should bid when their expected profits for bidding are no less than their costs of participation.[7] The vendor's decision to participate and invest or forego possible opportunity costs is risky, as it depends in no small measure on how many others it thinks will also compete in the same business.

The individual decisions to bid are often simultaneous, must be made in absence of knowledge of the number of committed bidders, and only after being made do they determine in aggregate the number of bidders. Each seller's decision to bid or not to bid is an event with two-outcomes, with probability of participation conditional on expected profit prior to the bid decision exceeding sunk costs.[8] What basis does the potential bidder have for knowing how many rivals he is likely to bid against? Note the chicken –and-egg situation in the behavioral dilemma. The number of rivals emerges from the process of all possible competitors wondering what each of their opposite numbers will decide. A difficult question is raised by this uncertainty. When the number of bidders is endogenous, does a competition that seeks to attract sellers by offering them greater profits possibly result in smaller vendor profits due to increased competition engendered? (Hansen 1988). The answer is in the expected tradeoff between entry incentives and competition. In a probabilistic sense a more profitable award will usually lead to a higher expected number of bidders.[9] Of many arguments in favor of multiple sourcing, one has to do with whether the number of bidders who compete can be increased by reducing risk of non-selection. Overall, multiple sourcing allows more than one bidder to succeed, raises profitability, and reduces non-selection risk Therefore it attracts more bidders, which in turn decreases overall profitability. The net effect is to increase the number of bidders up to the equilibrium where lowered profitability from increased competition serves to balance the enhanced entry incentive (Seshadri, Chatterjee, and Lilien 1991).[10]

Information from numbers of bidders: For any given award, a higher numbers of bidders usually results in more aggressive bidding and a lower award price. This intuition is true for independent private values competitions; however, it does not carry through to common values and affiliated values competitions. Empirical studies show that more bidders are correlated with higher bid prices in many types of construction contracts. Theoretical explanations from non-private values settings suggest that the winner's curse phenomenon and the affiliated values effect intensifies with higher numbers of bidders, and may swamp out the

competitive effect (Hong and Shum 2002). Of course, as awards become more profitable they attract more bidders as well; so endogeneity of the entry decision is an important competitive setting issue, as is the affiliated or common values issue.

What will the buyer gain from revealing the numbers of bidders? The buyer keeps an open list of sellers who can request a copy of the RFQ. These are the qualified or potential suppliers. The *maximum* number of potential suppliers is usually known. A policy of concealing the number of bidders never results in higher expected sourcing cost for the buyer who is facing sellers with constant absolute risk aversion. In fact, "honesty is the best policy" and bid takers are best in revealing all their information, including any information they may have about the number of bidders, to all bidders when bidders have common knowledge about the bid takers private information (Milgrom and Weber 1982). The rationale is that when information is concealed, bidders will assume the number of bidders is low and would bid less favorably (Rasmusen 2001 calls this the "no news is bad news" thinking). The buyer therefore prefers a policy of revealing to concealing the number of bidders when possible. As we have seen this may not be possible. Shared learning is valuable as the contract progresses into its post-award phases.

9.6 Pre-award and post-award competition

Do source selection issues go away once the buyer makes its initial award? The sort of problem discussed in Chapter 5, where competition may exist prior to the sourcing award but disappears once the award is successfully contracted, is a motivation for multiple sourcing. The ability to re-procure competitively requires sequential auctions, where contracts are executed periodically. The incumbent suppliers would need to bid competitively to keep their business of share of business for the next round of sourcing contracts. Special considerations are key to designing such auctions, such as investments in cost reduction, and the learning curve or experience curve that would reduce incumbents' cost estimates for the second round of re-procurement (see Laffont and Tirole 1988; Klotz and Chatterjee, 1995; Lee 2000).

Second sourcing: A second round for the source selection decision allows the buyer additional strategies. The buyer may hold a second reverse auction, or not; it may switch suppliers or add suppliers; it may bias the award to favor the incumbent, or favor the entrant; it may change terms of the contract in critical ways with different terms for an incumbent and entrant. What is the optimal choice among these strategies in second sourcing, and what are consequences for supplier responses? Much depends on whether there is scope for investments, whether investments are transferable, and whether the buyer can observe these investments.

The simplest situation is when there is no scope for investments or learning. Then the buyer has nothing to gain on this count from a second sourcing selection. The second round will be identical to the first, and the same award is repeated. One reason for such reprocurement to occur anyway rather than a single comprehensive buy is capacity reservation constraints. The supply base may not have sufficient capacity for the entire requirement within one period, or demand is too uncertain, or inter temporal commitment to buy is too expensive. The buyer must balance information rents that suppliers extract with each round of bidding against the saving in its capacity reservation costs.[11]

The more interesting situation is when there is scope for supplier investment or learning in the initial contract but the gain is not transferable to other rival vendors in the supply base. The incumbent then acquires property rights from its investment while executing the first round. The symmetric bidding situation is replaced with an asymmetric reverse auction in the second round, with the incumbent supplier at a cost advantage. The optimal auction in the second round then is to favor the entrant, and bias the selection decision against the incumbent. This means the incumbent must bid sufficiently lower than the entrant to retain supplier status. The need to bias the selection is consistent with the marginal expense interpretation of the optimal reverse auction in §8.12 and Exhibit 8.2. The incumbent with a lower cost distribution due to investment benefits in the first round now has an even lower marginal expense curve, and should be put at a disadvantage in the optimal asymmetric reverse auction.[12] This means that the marginal expense curve should fall, and the award price (corresponding to the same second best marginal expense as in the first round) should fall. The winning bidder must bid even lower than this new award price to win the contract, not merely lower than the entrant's reserve price for it to retain the contract. In sum, the entrant is favored in the second bidding round. Whether the investment is observed or not, the recommendation holds for the optimal auction and it is strictly better for the buyer than holding independent auctions (Luton and McAfee 1986).

What changes when investment is transferable? The second source could then take advantage of all gains from the incumbent's investments in the first round. In a sense, this transfers property rights of the incumbent to the second source if the entrant is successful, yet effort costs are borne only by the incumbent. Intuitively therefore, the award should allow the incumbent some concession relative to the previous nontransferable investment situation. Take the case of observable investment first. The situation is back to symmetric suppliers as investment is transferable and since everyone can observe investment and there is no externality for the incumbent. This means the buyer can compensate the incumbent to the extent of the investment and suppliers choose the optimal investment effort. The optimal second round reverse auction here is one of bidding parity, with no bias in favor of either incumbent or entrant. This is just like the no investment situation except that costs are lower for the buyer and suppliers. We are back to the independent optimal auctions scenario.

On the other hand, when investment is unobservable the incumbent will not be fully compensated for its effort and yet the second source could reap all benefits from transferable investment. The optimal second round reverse auction now will require bias in favor of the incumbent in order to provide effort incentives. What is more, incentives for effort should be most in the initial round to best reduce acquisition cost. This can be achieved by a low sharing rate (cost reimbursement plus incentive fee) type of contract in the initial round, to be followed by a high sharing rate (fixed price plus incentive fee) type of contract in the second round. With a lower sharing rate the buyer pays for more effort cost (Laffont and Tirole 1988).

All these principles apply even when vendors are risk neutral. When risk averse, the magnitude of the incentive and selection risk effects intensify. The incumbent should be even more favored in the break out bidding in the second round. The initial round should tend toward cost reimbursement and the second round should resemble a fixed price contract. Recall that in a cost reimbursement type the buyer pays fully for effort costs, and in a fixed price type contract suppliers bear all effort costs.[13]

Bid subsidies: The manner by which the post award phase subsidizes the pre award phase is integral to the initial reverse auction mechanism. An incumbent who bids competitively secure in the knowledge that it will not be replaced when the buyer procures the same items again has incentives for pre-and post-award strategic pricing. For instance, in the unit-price contract (UPC) auction the bid taker announces the categories, items and quantities required and bidders submit unit prices for items. The bid taker then assigns an overall score to the bid, using a known scoring system. The bidder with the best overall score wins the contract. If there is no sharing of cost overruns and under-runs due to mis-estimation of quantities there may be adverse incentives in such UPC bids. Worse bidders may actually win by gaming their unit prices where they know the bid taker has poorly estimated quantities required – of material or labor for example – and have a high unit price here, that subsidizes their low unit prices where quantities may be over estimated.

Knowing this why should the buyer ever use the UPC? The buyer may sometimes prefer UPC auctions since subsidizing leads to greater competitive pressures on better bidders, allowing the bid taker to extract information rents (Ewerhart and Fiesler 2003).

9.7 Conclusion

Vendors in the supply base are not naïve and passive in the face of buyer reverse auctions. They are likely to have interests that are not perfectly aligned with the buyer's objective and would adopt bidding strategies that serve their own interests. Rival behavior therefore changes with reverse auction awards, and we characterize equilibrium bidding strategies as mutual best responses to both rivals

as well as to buyer award choices. Awards change the ways bidders relate their bid offers to private reserve utilities and opportunity costs. This chapter emphasizes the importance of opportunity costs in understanding supplier bidding behavior. It relates opportunity costs to bidding strategies and buyer evaluations when efficiency principles (related to governance and capacity management) are important in addition to acquisition cost minimization in selection mechanisms. It also elaborates on dynamics of bidding strategies with the impact of the number of bidders, and the entry decision that determines these numbers. Dynamics are also apparent in the role of multiple sourcing and sequential reverse auctions.

The next and concluding chapter in Part 1 is concerned with an aspect of the performance gains goal in sourcing. It outlines demands for effective implementation of sourcing processes. Here we translate the architecture we used in earlier chapters to entities, workflows and uses for effective implementation.

10: Sourcing Reports and Data

10.0 Introduction

"Strategy is as good as its implementation" is an adage well known in business. A key determinant of performance gains from a modern sourcing strategy is its information system support. Earlier chapters raised performance related concerns. For instance, information and computation support is required for assessment of supply base capacity utilization; for expected award pricing and acquisition cost estimation for incentive compatible selection mechanisms; and for contract parameter sensitivity to incentive risks. Implementing sourcing strategies in the modern firm is an exciting growth area in information and communication technology, or what is now called the ICT discipline. Both small and large firms in the "spend management" vertical have developed large blueprints for the development of sourcing plans and platforms, and detailed some areas for niche applications. This chapter outlines the architecture of ICT support systems for sourcing strategies. Sourcing strategy architecture includes workflows, reports, use case scenarios, algorithms, processing engines, and databases necessary for implementation in a responsive and scalable manner. It is necessary that such implementation be compatible with other modern business functions that have migrated to enterprise wide platforms. Levels of skills needed for sourcing responsibility in the firm are therefore changing. The firm re-engineered for sourcing strategy is likely to have a sustainable competitive advantage in a globally competitive world.

10.1 Workflows and Reports

The activities in sourcing span the initial conception of requirements, to successful completion of the acquisition. Workflows occur across several organizational levels and job descriptions, and take place over extended periods of time. With the wide variety of goods and services that are outsourced business rules in these workflows should be flexible. Often buyers and sellers may bypass some activity stages, or introduce additional activities in special circumstances. For instance, outsourcing of facilities management may require annual maintenance contracts (AMC) that recur indefinitely subsequent to an initial design, installment and commissioning. Sourcing rules governing AMC will differ substantially from that of facility acquisition.

Policy derived from sourcing strategy guides development of business rules in these diverse cases. Policies are usually reflected in staged reports. Responsibility for implementation of policy can be met only when the responsible party receives proper reporting on directives and execution of activities in a timely fashion.

BoQ and estimates: The bill of quantities is an origination report for a sourcing process. The buyer develops categories and specifies items that will be outsourced. Categories are developed on a variety of considerations. Typical categories are materials and labor, or MRO and direct materials; or commodity, engineered, or service categories. Some atypical categories are useful in special circumstances. For instance categorization on critical to quality (CTQ) supplies may be useful for firms involved with six sigma quality processes. The level of detail on item specification depends on familiarity with the sourcing. Item description and quantities required of the item will comprise the bulk of technical specifications of the BoQ.

The buyer will require an initial estimate of cost associated with each item. As this is often a difficult process especially for volatile technological and economic environments, the buyer would develop its most likely costs and a range around this point estimate that reflects its uncertainty. The buyer's estimate is an indispensable part of the BoQ as it provides the initial basis for budgeting sourcing. However, buyer estimates are completely confidential and revealing this to any supplier is highly damaging to integrity of the sourcing.

RFI: What if the buyer has little basis for deciding the BoQ and its ingredients? In greenfield situations this is often the case. The buyer will require help of potential suppliers to develop item specifications, and quantities required and often also need commercial information to develop budgets. Suppliers are under no obligation to provide this information or even to adhere to the information if they do provide estimates, as the formal document for technical specifications is still under development. The Request for Information (RFI) is a report that buyer's develop in order to fill in gaps in their Bill of Quantities.

Vendors are often motivated to assist buyers in this stage as the buyer may be prevailed upon to adopt specifications that particularly suit the vendor's strengths. The vendor would then obtain a competitive advantage in the bidding process to follow. Suppliers may propose alternatives to initial conceptions on designs and materials. The RFI also seeks vendor specific information to populate a database on potential suppliers. The buyer elicits key information for vendor qualification such as financial viability, and technical competence. The buyer evaluates suppliers on these as well as their preliminary information on technical quality and commercial interest.

RFQ: The buyer then details technical and commercial terms in a Request for Quotation (RFQ). The buyer finalizes sourcing strategy at this stage. The specific award type and the contract parameters are integral parts of sourcing strategy design. The complete RFQ specifies all contractual terms, including standard boilerplate suitably modified for the sourcing scenario. Algorithms that translate

the sourcing environment information from RFI to detailed policy based designs of the RFQ are internal to the RFQ engine.

The buyer invites potential suppliers who have passed RFI screening to bid on the RFQ, or publishes the RFQ for wider participation. Participants learn of deadlines for submission of technical and commercial bids. The final bid development process gets underway and the supplier may incur substantial cost for better designs and program estimation.

The suppliers' response to the RFQ is received and consolidated. The buyer evaluates technical aspects of suppliers' bids, followed by commercial aspects, and awards the contract based on terms of the RFQ. Buyer's commitments and selected supplier commitments are now clear and formalized to the extent possible prior to the sourcing relationship.

Supplier profiles: Sourcing policy helps determine what details on supplier profiles are relevant to design of sourcing strategy. The number of qualified potential suppliers, and their capacities are key information items. The risk attitude of the supplier is essential for appropriate design of contracts. The perception of uncertainty associated with the particular sourcing is a key input to parameterization of contracts. These profiles provide necessary information for the sourcing environment. The RFQ engine translates these aspects of the sourcing environment to contract design based on buyer objectives. The right suppliers, in the right numbers are awarded portions of the unit contract. The long term development of the supplier base depends critically on the ability to include the right profiles into the supplier footprint. The workflows follow business rules intended to deliver these kinds of information to users.

10.2 Users and Uses

The users of an implementation, both in the firm or agency and outside the organization, represent various roles. The buyer usually is a "buying center" and the seller is also a "selling center" with multiple levels of interactions. Tasks that individuals engage in follow the buying cycle and stages. As RFI and RFQ process described above progresses, individuals involved may change. Typically there are clerical, functional and strategic users. These may actually be the same individual who wears many caps in the sourcing process.

Clerical, Functional, and Strategic: Clerical users are those who input data and maintain records; These are usually designated individuals in the buying center who input engineering needs into items, specifications, and quantities. Functional users are those who develop procedural rules in sourcing. They aggregate demand over buying centers, and across decentralized buying budgets for identical or substitute items. They administer opening and closing dates for RFI and RFQ and move the sourcing process from stage to stage on the workflow. Strategic users are those who confirm or modify the characterization of the sourcing environment, and ultimately design sourcing strategies. They analyze

the sourcing process into scenarios that demand specialized sourcing designs. The strategic user is responsible for breaking the entire process into phases, and choosing appropriate strategy for each phase. These phases span the product life cycle and may be for instance, the development phase; the early supplier involvement phase; the launch; and mature product phases. He or she takes ultimate responsibility for the success of sourcing strategy.

Selection formats: Users need reports that help them select suppliers for specific RFQs. RFI information sent by the buyer to potential suppliers helps them decide whether they should be interested in the eventual RFQ. The RFQ information contains detailed technical and commercial terms and is the ultimate basis for the vendor's participation and bid. The consolidated response to the RFQ from participating vendors is the final stage of selection and summary reports from this consolidation should aid selection. The buyer should readily retrieve total costs across categories and for the entire program. Quality ratings that compare supplier offerings should be possible from the response to the RFQ. The buyer invariably has a compensatory choice model with relative importance weights for price and quality. Selection reports should present the summary evaluation of qualifying supplier bids to facilitate choices.

Contract formats: The RFQ contains details on the type of contract that governs sourcing. Parameters of the contract, such as sharing rates or number of selected suppliers, will also be specified. Terms and conditions accompanying specific contract forms must be attached to the RFQ. All agreements must contain authorization and legally binding signatures. There are many standard contract types, and in later chapters we discuss several of these with their key design parameters. Contract formats that involve future pricing such as targets that will be adjusted with information to be acquired at a later date require special formats. Some index contracts require ways of inputting commodity index prices and adjustment formulae.

Most contracts require monitoring and all but fixed price contracts require some kind of supplier cost audit. Milestones at which the buyer makes these audits and progress payments will need to be part of the contract format. Several instances of sourcing require master contracts between headquarter offices, supplemented with repeated purchases conforming to master contract terms. Aggregation over time and across buying centers of the purchase volume from a given supplier under the master contract is a necessary reporting task. Data for these reporting tasks come from many sources.

10.3 Data warehouses

There are several sources of data relevant to sourcing strategy, and integrating data from these sources leads to warehousing concepts. The general ledger is a major source, as is invoice data and data on accounts payable. Requisitions and past purchases, both currently being executed and those closed, are all likely to

hold valuable information for the next RFQ. Data warehousing aims at consolidating many fields and records across different locations, buying centers and sometimes even companies, for better data access and retrieval. Technology for integrating diverse source of data under various data structures is available.

OLTP: On Line Transaction Processing, or OLTP, generates a vast amount of data for purely clerical or functional purposes of transaction handling. Electronic catalogues, billing, or more generally electronic commerce practices generate such information. However, this data is likely to be valuable for strategic purposes as well if analyzed with appropriate models. For instance, billing data from a supplier is aggregated to provide a share of business estimate for the supplier that is used to motivate the supplier for competitive design effort.

Timeliness and relevance: The real time nature of sourcing decisions is a reason why buyers and suppliers are particularly concerned about timeliness. Contracts and payments are based on net present value calculations. Progress payments to suppliers are ways to incorporate real time effects of business returns on assets. Award mechanism, such as decreasing price or Dutch auctions, use time bound offers in an open cry auction method. Selection processes are every sensitive to time. Capacity commitments by suppliers and re-procurement commitments by buyers are notoriously dependent on time. Allocation of fixed costs to sourcing business depends critically on the period of work, and duration aspects could be contentious. This is so characteristic that term "period cost" is used to describe time sensitivity of allocations. Time responsiveness of the sourcing system is a critical determinant of its usefulness.

Comprehensive: Absence of data makes sourcing decisions ad hoc. The more comprehensive data, the more systematic strategy can get. Internal data at best focuses on the firm's particular history of sourcing, and external data is necessary to provide a binocular view. External data includes econometric information, relevant global trends in supply chains, collaborator and supplier information, customer preferences, and competitive activity. Sourcing strategies that access data from all these sources are better able to bring predictive analysis into their formulations. For instance, all these sources of information are ingredients in computation of growth rates in market share. Sourcing of industrial components is critically dependent on such predictions. Analyses, such as forecasts, that routinely draw upon given fields of data can be organized in datamarts or databases.

10.4 Databases

The integration of data in data warehouses is usually a centralized enterprise-wide activity, and additional local and decentralized data generation work is often needed. End users require special datasets for their particular sourcing needs, and confidentiality considerations are relevant. Both buyers and suppliers may separately access a database on the buying center's recent RFQs. Item level

information is required for re-procurements and estimates for new budgets. Buyers will access information on a supplier database. Knowledge of the supply base ability to responds to demand shocks, stock outs, and surges as well as its risk behavior is relevant to sourcing strategy.

OLAP: On Line Analytical Processing, or OLAP, is the ability to take planned and selected views of the data in warehouses or data marts designed for particular users. The key to planning and selecting views is to figure what summary information to include and what relationships in data to seek. Typical OLAP exercises require records that are time stamped and location stamped. Records are tabulated and cross-tabulated along various fields and aggregated to display "cubes". OLAP aggregates and summarizes descriptive information from all stored data, or from data filtered and screened on specific criteria. There may be various types of descriptive statistics associated with these views in order to identify significant differences and associations. For instance, a buyer may use OLAP to view the percentage of business sourced from a particular factory of a given supplier in the last quarter. OLAP tools are available from most database vendors.

Retrieval and updating: A major uses of sourcing information is retrieval for reuse. Generation of new RFQs requires the buyer to efficiently retrieve related previous RFQs and suitably modify them. Updating information in the sourcing database is a continuous activity. Routine changes in supplier information, additions to capacity and capabilities, and new products and technologies are part of supply base evolution.

Enrichment: Managers capture experience with sourcing strategy with evaluative ratings, such as supplier satisfaction and customer satisfaction. These report cards associated with RFQs allow the sourcing strategist to improve over time. The "closed loop" approach to database design requires the manager to maintain and merge information from interventions based on the database. For instance, a buyer or supplier may add fields to a RFQ database on winning bids, in order to determine trends in the supply base price competitiveness. A buyer may include information on a supplier development program such as training, for a determination of returns to investment from future price and quality improvements. Typically such ROI requires comparisons across segments, territories and products and is possible only by mining large datasets.

10.5 Data mining

Process adjustments are guided by data mining, selective drill down and roll up, and slicing and dicing of tabulations of data. Raw data stored in data warehouses is served up to specific users for particular data mining applications in data marts. These data mined decisions are more intelligent than those that rely solely on manager know-how.

Business intelligence: The explosion of data from OLTP and of data driven information from OLAP has posed the question: How "intelligent" is our business? This now means: How well are we using information we could store and retrieve? Availability of powerful data processing tools allows identification of patterns in processes that were hitherto hidden. Early applications were in identifying patterns of production reliability and conformance quality. The vast growth in business intelligence is to do with patterns at the boundary of the firm's activity. Customer relationship management (CRM) has brought business intelligence to functions such as direct marketing, price promotions, customer care, and segmentation. Supplier relationship management (SRM) brings similar value to risk management, inventory and demand planning, value addition, supply cost management, materials handling and incentives.

Techniques: Popular techniques in intelligent business data mining are clustering, classification and regression techniques, and neural nets. Clustering of records is accomplished by grouping them together on similarity of their data on multiple dimensions. For instance a set of products purchased may be clustered on similarity of their items, or a set of suppliers may be clustered on similarity of their profiles. Classification and regression techniques (CART) are useful for segmentation of the database. Partitioning of records is done on the criterion of interest, usually a response to a buyer decision. For instance, all items are partitioned on their value in categories of low, medium and high cost. The approach derives characteristics of the item that allow classification into the category, say low cost, along with statistics on frequency of these characteristics in the dataset. Neural nets develop predictive relationships and quantify these with coefficients of association. The multiple paths or links in the net may not be explained, but are driven by data structures, and prediction is the main criterion. Some latent nodes can be specified for grouping links.

Applications: Devising of sourcing strategy and its refinement can find validation in business intelligence. Creative approaches to strategy are possible in the absence of such techniques. Yet their use in monitoring and evaluation can greatly enhance implementation. Clustering and CART enables supplier segmentation for RFI and RFQ solicitations. Product and item segmentation is useful for a bundled purchasing strategy. Neural nets help predict technological trends and complex behavior of price indexes. These predictions can help plan options and hedging approaches in sourcing. However, the advantages of such approaches are evident in other business processes as well.

10.6 Linking with the ERP

Business processes are highly demanding of resources and enterprises are very conscious that efficient allocation and management of scarce resources are critical to business success. Outsourcing is probably the most resource intensive process in the enterprise as cost of goods sold is above 50 percent on average. The

importance of its efficient management is indisputable. However, other processes in the enterprise are also important to value addition. The manufacturing processes, or distribution and retailing processes for instance require resource planning that has its own dynamic. The enterprise resource system (ERP) of the firm is likely to have several modules that represent different processes in the firm, and linking sourcing strategy to the overall ERP is an important enterprise issue.

Motorola has deployed an e-sourcing platform that enables strategic sourcing functions online, such as:

i. collecting supplier information
ii. aggregating demand
iii. managing request for quotes
iv. reverse auctions
v. multistage negotiations
vi. analyzing complex supplier bids

Source: Purchasing pros seek complete e-sourcing negotiation solution. Supplier Selection and Management Report, March 2004, page 11.

Interfaces: Interfacing of supplying and sourcing systems between vendors and buyers is critical for supply chains. Often developments on one side of the relationship are not reflected in the other side. Standard ERP platforms in the ICT industry have evolved to allow modular growth in applications and interfaces. Specialized niche sourcing applications become possible with modular implementation. Software approaches such as CORBA allow implementations in multiple programming languages to talk to each other and exchange data and reports. Linking departments within an enterprise, or between firms using diverse ERP systems across the supply chain is now easily done with intranets and browser-enabled technologies. Universal interfaces allow collaborative approaches across the supply chain in sourcing.

Synergies and enhancement: Links between other business processes and sourcing processes lead to synergies for the firm. A major synergy is the production efficiency of make-to-demand and just-in-time (JIT) assembly. Changing customer preferences can be reflected in design modifications far more rapidly, and marketing effectiveness is a major synergy. Redefinition of sourcing functions and jobs to improve employee productivity, visibility of performance, and job satisfaction is a major human resource advantage.

10.7 Resources and training

Acceptance in the firm or agency of sourcing process re-engineering is dependent on appropriate incentives and training. Organizational structures necessary for modern sourcing may be in conflict with traditional or legacy

practices. Conflicts could arise due to divided responsibility or competition for rewards and recognition. There are also conflicts of interest possible within roles. For instance, logistics and receiving could both have responsibility for smooth materials handling; yet there are different interests due to damage in transit, and competition for storage space. Sales and commercial functions from the supplying end have conflicts of interest due to sales personnel commitments to client relationships and commercials personnel commitments to internal accounting. Business rules arising from sourcing policies must account for conflict resolution.

The service provider must train clients on clerical tasks such as forms and protocols. Training on RFQ development and database management is necessary at the functional level. Design of sourcing strategies is a felt need for executive education.

Knowledge and skills: Executive responsible for sourcing strategies should recognize the importance of the business process in company affairs. Corporations should develop corporate level strategies for sourcing, and senior management should issue clear directives at divisional and strategic business unit levels. This requires a breadth of knowledge that is very challenging. Managerial economics of sourcing and operational management of sourcing combine in an intimate manner. Managerial skills in an information intensive business process are welcome advantages. The manager develops skills and interest in using decision support systems, expert system, and e-commerce approaches. Deploying such systems within one's organization is almost as much a challenge as is influencing the supply chain to follow likewise.

Infrastructure and delivery: Hardware and software for sourcing services and sourcing systems spans the spectrum of information communications technologies (ICT). Infrastructure can usually be outsourced to system integrators and application service providers (ASP). The buying organization could alternatively implement an internal server based software platform with thin clients, and often has decentralized databases as well. Delivery of sourcing services, whether internally organized or outsourced to service providers, must be timely and reliable for various end users in the modern corporation. Systems should be scalable as the firm grows and products and services procured increase.

How many Buyers?
A huge percentage of employees are buyers, much more than those in administrator or manager positions. One study found there were about 1.6 buyers for every £1 m. of expenditure. *Source: Quayle, Michael (1998) The impact of strategic procurement in the UK government sector. International Journal of Public Sector Management. 11, 5, pp. 397-413.*

10.8 Conclusion

Implementation of the right architecture in information systems design and technology support is critical to achieving performance gains from sourcing strategy. The architecture for information systems this chapter describes is consistent with the conceptual architecture for sourcing strategy in Chapter 2; and has the capability of generating required reports for strategic decision support.

In sum, Part 1 has concentrated on principles and policies for strategic sourcing processes. In Part 2 we turn to designs of sourcing processes in standard scenarios. These designs illustrate principles and policies and use exercises from software implementation of designs for further quantitative insights.

Outsourcing of outsourcing

Outsourcing the procurement function as the next BPO domain is set to expand, as corporate management begins to take cognizance of this source of sustainable competitive advantage. A study shows that more than half European and US companies are considering outsourcing their procurement functions. Value is the foremost reason for growth in this BPO, followed by costs, and third party procurement service providers provide strategic sourcing advantages.

Third party BPO of procurement from procurement service providers (PSP) in direct materials is anticipated by about half the study respondents. For indirect materials, outsourcing of outsourcing is anticipated by over 40 percent respondents. Of the companies considering PSPs most were particularly keen to outsource the e-sourcing function, and already about 40 percent had already outsourced the IT hosting aspects, as testimony to the RFx and auction process capability.

Sources:

1. Why outsourcing the procurement function is poised to expand. *Supplier Selection and Management Report, 4, 2, February 2004, page 1.*
2. www.idc.com "Worldwide and US Procurement BPO forecast and analysis, 2002-07";
3. www.accenture.com "Procurement outsourcing: The next wave" www.bpo-outsourcing-journal.com

Appendix: The CPO view from United Technologies Corporation

The Chief Procurement Officer is often the latest member of the corporate team. What are his or her concerns? The following commentary reveals many of key considerations. *(Source: United Technologies' Vice President Supply Chain Management, Kent Brittan, Financial Times Presentation, 27th January, 2000. Quotes are excerpts from the article).*

United Technologies Corporation or UTC is well known for its focus on tight cost controls. With interests in diverse manufacturing operations such as elevators, jet engines, and air conditioning equipment, it has enormous scope for supply base management. VP Brittan is very aware of the challenges:

"Supply chain management, like most things in life, has always been about data and information -- volumes, price, lead-time, quality, and specifications. The people who can master the data issues, that is by mastering the tools available today, will be the winners in supply management."

The costs of goods have direct and indirect impact on operating expenses. Distributed costs across the corporation make controls difficult. UTC requires purchasing of $14 Billion of goods and services from about 60,000 suppliers. VP Brittan assesses that:

"... the indirect costs of purchasing -- inventory, accounting for inventory scrap, environmental costs, etc., push this percentage even higher. At UTC, our total spend of $14 Billion in 1999 was 65% of our total cost and was split into a 60/40 ratio between product and general procurement spend."

Indirect costs are insidious, difficult to track and allocations to specific products are always contentious. They nibble away profits and reducing them is a war of attrition. VP Brittan describes these succinctly:

"Let me start with the 40% - General Procurement. This is the travel, cafeteria, office supplies, etc., that we need to run a business. Each individual transaction doesn't amount to much but in aggregate they represent at least 10-20% of sales to the average company. In fact, many people outside of the purchasing department are buying things."

While aggregation of myriad costs is necessary, so is the slicing and dicing of such costs in ways that can identify savings. VP Brittan emphasizes drilling down to the details is necessary for effective action:

" But you can't reduce what you don't know. That is, you can't make an agreement with a supplier without knowing how much you buy. But even that isn't enough. You can't go to a paper company and say "we buy a lot of paper, let's do a deal." You need to know not only how much, but what types of paper. You need to tell an airline or a trucking company what routes you use, the volumes, etc. When you are in this General Procurement area the transactions (the individual events) are not only in the thousands, they are often in the hundreds of thousands or the millions, of requests, invoices, and reception involving thousands of people."

The idiosyncratic professional culture of many buying organizations is subject to standardization and categorization. Homegrown and sometimes freewheeling logic of older processes must be challenged for behavioral change, but the emerging logic leads to better mind sets and behavior. As VP Brittan points out:

"The business-to-business (or B2B) Internet world wants the individual to order against a defined list of items whose price and delivery schedules have been pre-negotiated by the company using a common system. For most organizations switching to this new way of life – because of the decrease of freedom and the

need for re-engineering of the order and fulfillment processes -- is a wrenching cultural change for the employees and a dramatic productivity improvement for the company. I have lived through the installation of a complete requisition to payment system covering virtually all of our general procurement spend (which amounts to hundreds of millions of dollars). It has been difficult, but a great learning experience.... But acquiring the learning, doing the re-engineering, bringing about the cultural change, require a much longer response time and could create a big handicap to overcome... One of the key learnings is that price is only about one-third of the potential savings in many commodities; the rest is to be found in process improvement and inventory... In UTC's case the old General Procurement process was to have a requester, a buyer, a receiver and a payer. All these activities were performed on a very decentralized basis. We essentially have gone to a requester (still decentralized), one centralized buying group, and a system. There is increased efficiency and lower prices from the concentration of spend and compliance."

But the sourcing process is neither monolithic nor uniform across the board. Products differ and sourced components or assemblies have characteristics that result in different practices. Business rules in sourcing must be tailored accordingly, and executives need special support systems beyond generic ERP or Business Intelligence tools, that would take a long time to deploy. VP Brittan recognizes need for flexibility and specialized sourcing designs for special scenarios:

"What about regular product purchasing, the purchase of all the electronics, the sheet steel, the motors, the machining, the plastics and all the other materials that go into inventory and into the cost of our products? In my case, UTC, this is about $9 Billion. Those of you who are familiar with purchasing know that "one size doesn't fit all," that is, the way you purchase something depends upon what you are buying and the supply market. In my diverse environment of elevators, air conditioners, jet engines, helicopters and space suits this is clearly an issue.

"...data that we need about our suppliers, such as, pricing, quality metrics, deliveries, etc., needs to be collected, stored, and made available (shared) among the many people needing it."

"... eventually fix this problem with an ERP system, time has caught up with us, and another solution has to fill this need...Apart from volume, price and production-specific data, other data such as quality metrics, production forecasting and scheduling, etc., are of interest to you and the supply base as well."

Sourcing information storage and retrieval is critical, but an even more basic need is the generation of such information with e-commerce applications. The single most successful innovation is the reverse auction. VP Brittan recounts similar experience at UTC:

"...showed on-line bidding or "reverse auctions" has proven to be an effective way to reduce cost for pre-engineered parts such as machinings. In an on-line bid pre-qualified suppliers bid against each other from remote locations for a certain

lot of parts. While the "event" itself is exciting with a lot of bells and whistles as the curve inevitably slopes downward, the key to success is not only in the technology but even more in the up front preparation which takes place in the six to twelve weeks prior to the auction day. During this period a detailed RFQ or request for quotation is drawn up where all requirements, such as, delivery schedules, quality, metrics, packaging, etc., are precisely defined with the single exception of price to be settled by the auction. This "leveling of the playing field," largely a "manual" process, requires a lot of field work, supplier pre-screening and judgment as how to "lot" the parts -- i.e., you need highly experienced and skilled people. The key point here is, as always, the technology has to sit on top of a robust process, otherwise it won't work."

The adage is apt for sourcing reform, that it is not a destination but a journey. Progress reveals how to achieve further progress. VP Brittan has a similar perspective:

"To summarize in a couple of words "There is no going back." Our experience at UTC with new technologies and process re-engineering is so positive that we are constantly looking at new ways of doing things in every aspect of Supply Management. From my perspective we are only limited by our imagination and the ability of the organization to change."

==========

End of Part 1

==========

PART 2
Design

Introduction to PART 2

How can the sourcing manager put insights from earlier chapters to work? Part 2 of the book brings together principles and policies in various standard sourcing environments, answers typical queries for strategy, and characterizes optimal decisions from differing perspectives of suppliers' and buyers. In this part of the book, the reader will appreciate how to quantify risk-reward tradeoffs for practical sourcing design decisions involving competitive bidding and contracting.

The modern executive performs a trapeze act every day between the qualitative and the quantitative. Part 2 is the other swing of the trapeze. While previous chapters stressed intuition and qualitative discussion, the chapters in this part stress rigor required for quantitative assessments of strategy. Therefore, Part 2 requires us to introduce measures of performance and formalization of intuition.

While we abstract away from mathematical formulations of formal models in this book, precise insights provided by these models are possible with the academic software program, Proxsys® (for Procurement Expert and Strategic Sourcing System), included here. The approach in each chapter is to discuss principles and policy issues for design of standard sourcing scenarios, periodically introduce a *Strategy Query* that focuses the reader's insight, and follow at the end of the chapter with an application that helps launch the reader into practical design of sourcing strategies in this scenario. A critical skill is the hands-on design of sourcing strategies with exercises that follow chapters using Proxsys®.

The introduction that follows is an overview of Part 2's chapters, and a consolidated *Strategy Query Checklist* from these chapters. We also include a mention of other texts on related issues.

11: Foundations of sourcing analysis: This chapter describes modeling fundamentals necessary to yield both qualitative principles and policy, and quantitative designs. Contrary to some partisan pronouncements, the sourcing executive needs both qualitative and quantitative insights for successful strategy.

12: Sourcing Design Elements: This chapter introduces the modeling superstructure relevant to sourcing strategy, such as utility functions, risk aversion measures, information asymmetry, principal-agent constraints, Bayesian

Nash equilibrium, signaling, auction models and linear incentive contracts. It demonstrates that these ideas are both simpler and more powerful than might be initially believed.

13: Risks and Rewards of Multi-Sourcing: This chapter develops the basic insights for multi-sourcing selection competitions. It seeks to dispel the mistaken view that vendors know the level of competition prior to their participation decision. It therefore develops the equilibrium notion that formalizes entry decisions into the supply base. The supply base capacity is hardly a given, and is influenced by the number of suppliers interested in competing. The chapter incorporates multi-sourcing benefits and costs for capacity development. The buyer's long term interest in supply base development, usually very easily ignored, can conflict with its short term interest in lowered acquisition cost. This perspective forms the basis for buyer risk-return tradeoffs from multi-source design. The chapter analyzes the popular auction format of fixed price contracts, with uniform first and second price award variations, and applies principles of revenue equivalence, the revelation principle and incentive compatible reverse auctions.

14: Capacity Constraints and Pricing: This chapter explicitly characterizes effects of supply base capacity development and individual supplier capacity constraints. Challenging the narrow and sometimes erroneous focus on a dedicated supply base, it considers a suppliers who have the option to sell in either spot markets or in sourcing marketplaces. Suppliers with capacity constraints in such parallel markets will develop a strategy of price-capacity "supply curves" for the sourcing market. Capacity constraints introduce the too easily overlooked "diseconomies of scale" situation for buyers. Buyers would find it preferable to split the purchase among multiple suppliers, even after factoring in escalation effects on bid and award price. A simplistic approach that conceals components of opportunity cost suppresses this insight. This chapter unbundles the capacity-constrained supplier's spot market opportunity cost as a price-capacity curve, and highlights long-term benefits of capacity development in the buyer's risk-return tradeoff.

15: Syndicates and Demand Risk: Web exchanges for B2B products and services by procurement service providers (PSPs) are young market phenomena, where horizontal risk sharing is viable. Horizontal risk sharing in the supply base is rarely considered a strategic choice, though it is a superior way to hedge volatile sourcing market risks. As syndicate sharing rules mediate prices and participation, past strategy recommendations on syndication were poor when suppliers had private reserve prices. There were likely mismatches between sharing rules and unknown supplier participation criteria. PSPs can overcome this strategy barrier by bid pricing in syndicates. Vendor participation interacts with syndicated bid price; and the pie to be sliced among suppliers is not as pre-determined as we might believe. The reverse-auction yields information necessary to implement the optimal syndicate's sharing rule. The chapter positions supplier syndication as a market for multiple agents. It shows how PSP

web exchanges can lower insurance required against demand-side business risks; and it determines the optimal number of suppliers to syndicate. Strategy thereby provides viable markets for vendors where it was thought none existed.

16: Risks and Resource Sharing: We return to the strategic issue of benefits and costs of capacity development in this chapter, but this time from risks and resource sharing perspective. The conventional wisdom is that the buyer makes a mistake when it indulges in supplier investment, as it disturbs the risk-incentive balance in sourcing and traps the buyer into a one-sided commitment to a long term financial relationship. Loans and progress payments cause similar strategic problems. Yet the small supplier needs interim resources and it may be cheapest to get them as vertical resource sharing from the buyer. The chapter proposes an equity sharing arrangement that integrates buyer financing of a supplier's operating or investment capital, without disturbing the risk-incentive tradeoffs. Naïve strategic beliefs on supplier reported cost estimates prior to investment causes problems with equity arrangements. A more experienced buyer may well believe that poor cost suppliers will misrepresent success of cost reducing investment to receive more funds under any equity financial arrangement. Credible communication of private cost reduction is, therefore, crucial for any arrangement to work. The chapter discusses a solution using the popular linear incentive contract to achieve risk allocation, and equity shares to achieve both cost signaling and funds recovery. Vertical resource sharing, thankfully, need not become a chronic and contentious issue.

17: Incentives, Innovation and Supply Risks: LIC: Choice between standard forms such as fixed price contracts, cost plus contracts, and linear incentive contracts (LIC) is often (wrongly) considered controversial. Part of the confusion is due to the artificial divorcing of selection and incentive risks; and part is due to ignoring strategic effects of joint cost allocations, and of risk allocation. The chapter focuses on design-and-engineering sourcing over longer periods. In the absence of joint cost allocations, the buyer finds it optimal to use bidding competitions for the popular linear incentive contracts even when risk allocation considerations are remote. However, volatile cost drivers and risk averse suppliers in such sourcing environments ensure that risk allocation is a pressing concern. Moreover, costs and benefits of unverifiable effort can affect supplier selection as well as payoffs. The chapter includes these strategic tradeoffs for both selection and incentive risk in the sealed bid reverse auction for a LIC. This chapter provides a benchmark approach to strategic sourcing in uncertain but partially controllable situations. The approach is difficult to improve upon, but special combinations of cost drivers may afford the opportunity.

18: Incentives, Innovation and Supply Risks: Yardstick contracts. In addition to beneficial effects on supply base capacity, multiple sourcing helps apportion risks in volatile markets. We discussed benefits for volatile demand scenarios in the syndication chapter. In addition, there could be benefits of multi-sourcing for risk from special kinds of cost drivers, especially those that underlie joint cost allocations, which we discuss in this chapter. The received strategic wisdom has

suggested only fixed price contracts as the alternative to problems these cost drivers create for LICs. This chapter proposes strategies based on yardstick contracts, specifically dual source contests. Commonly, past strategic approaches have artificially separated selection and incentive risks of award mechanisms, and led to contradictory beliefs on price effects of dual sourcing. Dual sourcing reduces selection risk leading to higher prices; but dual source contests can raise incentive risk leading to lower prices. An integrated view puts the confusion to rest and provides better strategy recommendations. This chapter analyzes advantages from using relative cost comparisons and differential rewards from contests for a winner's purse, and share of business awards. We discuss the strategic opportunity available to improve upon the benchmark linear incentive contract reverse auction.

The Exhibit describes and compares key features of standard sourcing scenarios in these chapters.

Strategy Query Checklist

The design scenarios allow us to pose and answer several recurring sourcing strategy queries more sharply. These queries are dispersed among the chapters, but we consolidate them here for reference.

- ***#1-*** *When should the vendor enter the bidding competition?*
- ***#2-*** *What is the probability of a bid from rival vendors?*
- ***#3-*** *What profit can the vendor expect before it knows its costs or the actual number of competitors?*
- ***#4 -*** *On what does the buyer's total acquisition cost depend?*
- ***#5-****How does splitting the contract affect vendor capacity investments?*
- ***#6-*** *Are there long-term buyer benefits from splitting the contract?*
- ***#7 -*** *How can we quantify the benefit – cost tradeoff for multi-sourcing?*
- ***#8-*** *Does multiple sourcing affect the supply base's propensity and potential to compete?*
- ***#9 –*** *Why should buyers consider reprocurements?*
- ***#10 –*** *Does the buyer gain by unbundling the supplier's reserve price?*
- ***#11 –*** *Should price determine supplier quantity or vice versa?*
- ***#12 –*** *How does spot market uncertainty affect sourcing?*
- ***#13 –*** *What are additional uncertainties in sourcing?*
- ***#14 –*** *What are the spot market price and capacity impacts on sourcing?*
- ***#15 –*** *How does capacity utilization in the spot market affect price.*
- ***#16 –*** *What is the "lots" option for capacity constrained suppliers?*
- ***#17 –*** *What is the "second quantity" award for capacity constrained suppliers?*

Chapter	Capacity	Risk	Uncertainty	Resources	Contracts	Reverse Auction
13 Fixed Price	Capacity development	Risk-neutral supplier; selection risk	Supply side costs	Resources not shared	Fixed Price	Uniform, first- and second-price
14 Capacity Constrained	Capacity constraints	Risk-neutral supplier; selection risk	Demand side, Search costs	Resources not shared	Price-capacity schedule	Uniform, first- and second-price
15 Syndicated	Capacity sharing	Horizontal risk sharing; selection risk	Demand side, competitive price	Horizontal resource sharing	Syndicate sharing rule	Discriminatory, second price
16 Equity Sharing	Constraints development	Vertical risk sharing; incentive risk	Supply side costs	Vertical resource sharing	Linear Incentive Contract, equity sharing schedule	Signaling, equity bids
17 Linear Incentives	Unconstrained	Vertical risk sharing;selection & incentive risk	Supply side, costs	Innovation investment with moral hazard	Linear Incentive contract	Uniform, Second-price
18 Yardstick	Unconstrained	Vertical risk sharing; selection & incentive risk	Supply side, costs	Innovation investment with moral hazard	Contests for purse or share of business	Uniform, Second-price

Exhibit Part 2: Summary features of standard sourcing designs. The exhibit compares and contrasts features of standard sourcing designs based on award type, and sourcing environment for which they are best suited.

- ***#18** – Why does divergence of joint cost from opportunity cost lead to buyer problems when fixed price contracts are not used?*
- ***#19** – What are advantages of sourcing from syndicated suppliers?*
- ***#20** – What are syndicate sharing rules?*
- ***#21** – How should a two-vendor syndicate share payoffs?*
- ***#22** – When will a vendor participate in a syndicate?*
- ***#23** – Can a reverse auction help determine the sharing rule?*
- ***#24** – How many vendors should comprise the syndicate?*
- ***#25** –When do buyers avoid long-term financial relationships with suppliers?*
- ***#26** – Why should buyers share resources with suppliers?*
- ***#27** – Are all forms of financial resource sharing equivalent?*
- ***#28** – How can the buyer recover its advanced resources?*
- ***#29**– Is the equity financial arrangement capable of credibly communicating private cost?*
- ***#30**– How do common and specific cost drivers affect the supply base?*
- ***#31** – Why should suppliers spend on cost control effort?*
- ***#32** – What is the preferred sharing rate?*

- *#33 – How does selection risk determine acquisition costs?*
- *#34 – How does incentive risk determine acquisition cost?*
- *#35 – What tradeoffs exist between incentive and selection risks?*
- *#36 – Why does risk aversion affect bidding for LICs?*
- *#37– Why does sourcing of design-and-production need special strategies?*
- *#38 – Why use relative compensation?*
- *#39 – How is the dual source award price different from the LIC?*
- *#40– How effective is the dual source contest for a "winner's purse"?*
- *#41 – Should the buyer de-link design and production contracts?*
- *#42 – How effective is the dual source share of business contract?*

Quantitative Texts

The past three decades has seen the emergence of a major theory of incentives. Landmark surveys of the theory of markets under imperfect information appeared in the *Handbook of Industrial Organization* published in 1989 (Schmalensee and Willig 1989). Given the vast scope of the subject of industrial organization, it is hardly surprising that sourcing finds scant mention. While the *Handbook* does contain a chapter devoted to the theory of vertical contractual relations, it does not contain a theory of auctions. However, main equilibrium concepts employed in theoretical work on sourcing contracts and auctions are contained in a chapter of the book (Fudenberg and Tirole 1989).

Professor Laffont's *The Economics of Uncertainty and Information* also dating from 1989 provides consolidated theoretical work of relevance. It shows how the Arrow-Debreu state-contingent general equilibrium model of the 50's had to give way to information asymmetries approaches (Varian 1984). His chapters on uncertainty provide all relevant results on decision-making under uncertainty, measurement of risk aversion, and certainty equivalents. The twin issues of moral hazard and adverse selection lie at the core of uncertainty and information asymmetry. There is a relevant difference for sourcing between pure moral hazard models and adverse selection models. The former postulates a stochastic link between effort and outcome (due to technology) in the presence of both effort aversion and risk aversion. The probabilistic nature of the link leads to welfare loss due to insurance. The latter postulates asymmetric information on ability, which leads to an information rent extraction problem. Professor Laffont's book characterizes the incentive compatible contract that trades of risk allocation and incentives. It also models the situation where the sellers' abilities are privately known, and characterizes self-selection, signaling, or auction mechanisms to extract information rents. Competition among agents with different privately known abilities leads naturally to models of auctions, in a later

chapter of the book. In this tradition is also Professor Salanie's *The Economics of Contracts: A Primer* from 2002.

Professors Laffont and Tirole published *A Theory of Incentives in Procurement and Regulation* in 1993 (Laffont and Tirole 1993). This *tour-de-force* of theoretical model development takes the self-selection model of contracting under asymmetric information of the adverse selection variety as a starting point. Professors Laffont and Tirole show that optimal contracts under effort aversion (including uncertainty, but not risk aversion) and asymmetric ability or type information (including asymmetric information on type leading to rent extraction problems) are menus of linear contracts. This linear contract looks a lot like risk allocation contracts of moral hazard – the so-called incentive contracts – but arise even in absence of risk aversion. Therefore, even without risk averse sellers and risk allocation issues, the optimal contract depends on audited cost, rather than a fixed price. Part III, Chapter 7 of their book introduces auctions into their architecture of self-selection models, with effort aversion (but again without risk aversion). However, they restrict their attention to selection of a single, most efficient bidder, the so-called winner-take-all award. This chapter in Professors Laffont and Tirole's book provides us with our point of departure for the economics of sourcing and sourcing strategy in this book.

11: Foundations of sourcing analysis

11.0 Introduction

Translating the architecture to a practical design of sourcing strategies requires us to quantify qualitative insights and associate numerical values with desirable outcomes. This chapter outlines basic concepts in the two-way trapeze act of qualitative to quantitative sourcing strategies. What are analytical representations of sourcing architectures that lead to predictive solutions? Meteorologists are quick to remind us we may measure but we certainly may not control everything we can measure. Yet it is also true that we measure to be able to manage that which we seek to control. Recall the important insight: The validity of direct incentive compatible bidding mechanisms depends on the argument that the buyer can compute optimal vendor bids better than vendors; a quantitative ability. Only through such computation can buyers design optimal selection and payment schedules. To do so in a manner that convinces vendors to truthfully reveal their costs buyers must have access to quantitative approaches and computational methods that enable design of optimal sourcing strategies. This chapter introduces key modeling considerations in this trapeze act, and these considerations determine models in Proxsys®, the included academic software.

11.1 Basic concepts in Bidding-contracting theory

As an interdisciplinary academic area, sourcing strategy is at the intersection of operations management, managerial and decision economics, B2B marketing and business strategy. Mushrooming research publications on sourcing have found outlets in journals positioned in all of these disciplines. Concepts and techniques that find application in sourcing strategy are therefore varied and inclusive. Standard scenarios for a basic description of the sourcing environment require a few key concepts.

Action and Decision: At a very general level, the decision process for buyers leads to actions that unfold over time with variations depending on specific objectives of sourcing. The actions are specifications of Bill of Quantities (BoQ), request for quotations (RFQ), award mechanism choice, evaluations, selection and rejection of suppliers and setting payments based on bids, auditing costs, determining and negotiating contractual payments and compensating suppliers.

The seller's decision processes result in actions regarding whether to bid or abstain, a specific bid price or its monetary equivalent, choice of level of investments in quality assurance and design or cost control when selected as a supplier.

Information structures: Learning unfolds for sellers and buyers as mentioned in economic and technological uncertainties. Most often cost is only estimated at the start of the program and sellers may share their subjective estimates of cost. They usually agree on common distributions of likely costs, and of profit alternatives to the program business, which may have common or private values. These probability distributions from which actual common or private values are drawn are usually common knowledge across buyers and sellers. As sourcing progresses, individual sellers learn their costs as they invest in technological capabilities and begin to execute the contract. These are privately known and only estimated by other sellers and the buyer.

Joint outcomes: The buyer and sellers are therefore restricted by their characteristics to choices from allowed sets of actions. The combination of choices they make among these sets of actions lead to outcomes for each of them, and therefore define a "game" between the buyer and sellers as interactive decision makers. In general, the sourcing mechanism allocates payments from buyer to sellers, and is compatible with the economy that uniquely assigns characteristics to agents.

Extensive forms, strategy space: Sourcing strategy involves actions followed by uncertain events, and the action-event series unfolds with buyer and vendors learning how uncertain outcomes pan out, and taking further actions on that basis. The sequence of actions-events define the extensive form of the interactive decision making process, and determines eventual payoffs to buyer and seller. A representation of this process with clear definition of information available at each stage, both on random events as well as actions of rivals, defines the extensive form of a sourcing strategy.

A sourcing mechanism compatible with this extensive form, defines a game played between buyer and sellers. For a simple reverse auction, once the buyer selects and award mechanism, the game is played between sellers. The set of strategies is characterized at the outset of the game. A representation of the sequential process as a rolled-back set of prior payoff expectations associated with action-events combinations is called the normal form of the game. A strategy is a complete set of instruction on how vendors and buyer could play the normal form of the game. It is precisely due to the fact that strategies of vendors and the buyer are interactive that the process is called a game. The strategy of any one party affects payoffs of all other parties.

For the contracting and auction games modeled here, the party's best strategy depends on the player's type or characteristic, the set of possible actions available to all other parties, and uncertainties. The equilibrium solution specifies the action drawn from the set of feasible actions, for any type of player drawn by natural uncertainties from the variety of feasible types. The question for the buyer of

how to select and reward vendors, of what vendor bids and allocation of payments rules will optimize its acquisition costs, translates to the question of which solution to the game is appropriate.

Solution concepts: Two major rationality criteria for sellers, as agents, are the individual rationality (or incentives) constraint and the participation constraint. The first states that the agent will seek to maximize its own objectives rather than principals, and perfect alignment is rarely possible. The second states that the agent must obtain a payoff, or an expected payoff, at least as great has its alternatives before it will participate in the business model proposed by the principal. The buyer, as the principal, recognizes this and determines the strategy that minimizes its acquisition costs by assuming this sort of rational behavior from sellers. The incentive compatible sourcing mechanism incorporates this concept of rationality. We state payoffs of agents and the principal in general in terms of their utility functions.

Analytical Foundations: The quantitative analysis of sourcing strategies has its roots in some key disciplines necessary to deal with decision making in complex business situations.

Probabilities: There are several uncertainties regarding events in sourcing. Uncertainties have to do with what outcomes will occur for a given event. The vendor can attach probabilities or a likelihood to outcomes associated with uncertain events. These probabilities could be subjective, and follow Bayesian learning. Thus, a vendor may not know its costs going in to bid, but will be able to assign a subjective probability density to the cost on its range or support. Once the stage of the process is reached, the vendor can undertake an estimation exercise to better determine its expected cost for the contract, and update its cost's probability distribution according to statistical rules. Typical probability distributions for quantitative assessments are normal, uniform, exponential and gamma.

Utilities: The vendor has an associated payoff for each action-outcome in the sourcing process. For instance, an action of participating in the bidding competition will necessarily mean an opportunity cost incurred whether or not the vendor wins with its bid. The payoff is in monetary terms but preference levels for the monetary outcome may not be so simple. The vendor's risk attitude usually influences the amount of preference a particular risky payoff may enjoy relative to a less risky payoff. The utility function is a cardinal measure to map a monetary payoff to a numerical scale that captures the vendor's relative preferences, inclusive of all other considerations.

Expected Utility and Decision analysis: Vendors may now view their decisions in action-probabilities-utilities combinations. Each action leads to a unique utility with assignable probability. The expected utility theorem from decision analysis allows the vendor to roll back all expected utilities to the prior point of choice. For instance, a vendor can roll back its expected utility from a uncertain competitive development contract to the prior point of decision of what to bid for the contract; or even earlier to whether it should choose to participate. It

is sometimes possible that vendors are risk neutral, like many buyers, and utilities are no different then from monetary values (von Neumann and Morgenstern 1947; Raiffa, 1968; Arrow 1971; Keeney and Raiffa 1976).[1]

Optimization: The actions the vendor takes affect its expected utilities not only through discrete choices, such as participation, but also through optimization of variables under its control. For instance, vendor effort comes at a cost, and the degree of effort is an important actionable decision. The vendor knows how its effort affects its profits and would like to choose the best balance between cost of effort and benefits of effort. The optimization approach allows determination of the internal maximum and minimum.

Constrained optimization and Programming: Constraints on actions will influence optimal solutions. Some constraints are simple threshold and ceiling constraints, that define an allowable range. For instance, vendor effort cannot be less than zero, whatever scale is used to measure it. Other constraints are more interesting involving relative magnitudes. For instance, the vendor's expected utility from participation in a bidding competition cannot be less than alternate reserve utility; both of these may be dependent on future events so a hard number cannot be given to the constraint. Probably most interesting are constraints that involve functional relationships, where we appeal to strategic issues. For instance, the strategic requirement that a vendor uses an optimal bidding function based on its private information given that all other rivals are using the same function based on their private information defines a symmetric functional constraint on optimization. These constraints lead to equilibrium strategies.

11.2 Equilibrium:

The crucial aspect for equilibrium strategy is that each seller knows that other sellers will act rationally; called the "common knowledge of rationality" criterion. Nash equilibrium as a solution concept assumes that each agent is acting in its own self-interest, as captured by its utility. The information structure of the economy, with private information aspects particularly, makes communication and collusion difficult to accomplish. The non-cooperative Nash equilibrium captures this feature, recognizing that self-enforcing agreements are impossible to sustain when not in the self-interest of the agents. The Nash equilibrium concept requires that no seller has an incentive to unilaterally deviate from using the equilibrium strategy.

The formal modeling of incomplete information structures of contracting and auctions in B2B markets requires Nash equilibrium for Bayesian games of uncertainty and asymmetric information, called the Bayesian Nash equilibrium (Harsanyi 1967). Each payer's strategy must be a best response to other players' expected strategies.

Symmetric Bayesian Nash equilibrium. The individual agent forms expectations on how competitors will bid and optimizes its response; if this

optimal response is strategically equivalent to expected strategy of its competitors, it is a symmetric equilibrium.

11.3 Adverse selection

The asymmetry of information on supplier efficiency sometimes leads to the adverse selection problem when the most efficient supplier does not get selected. Inability of the buyer to recognize the supplier's type, and inability of the supplier to credibly communicate its type make this a common problem. Buyers engage in bidding and auction processes mainly to overcome the adverse selection problem.

Credible communication: It is not easy for a vendor to credibly communicate its private information. The difficulty is that when the buyer does not observe the vendor's cost estimate, the vendor has an incentive to misrepresent it. A lower cost estimate yields a higher rating and potentially higher payoffs. Hence the buyer will have to see a signal that allows it to deduce the vendor's type information correctly. What can serve as this signal? The choice by the supplier of some observable message that costs the supplier in some way is a likely answer. A high cost supplier is unable to choose the same level of this message as the low cost supplier. Suppliers may differentiate themselves by choosing different levels of the message, provided the buyer is using a known formula to relate the message to private information. Under equilibrium, the supplier has no incentive to deviate from this message signal when the buyer is known to be interpreting the signal correctly (this is the signaling equilibrium condition as first formulated by Spence 1973).

Type-rents: The buyer must not pay for extra costs incurred by the supplier in signaling private information. This would ruin the signal, since the supplier would not be then able to distinguish itself from a less efficient supplier. Since the whole cost of signaling is borne by the supplier, it would be forced to ask itself whether gains from separating itself from other suppliers is worth the expense. When the answer is "no" suppliers choose a message that pools them all together as the same type. Signaling equilibria may therefore be either "separating" or "pooling", depending on the cost structure of the message. For less efficient suppliers the pooling equilibrium may be a bonanza, and they stand to gain type rents from the buyer's inability to distinguish supplier types.

Selection Risk: The buyer is usually able to introduce risk into the selection process in order to extract information on the supplier's type. If the supplier fears that it may not be selected unless it reveals its type, there will be a motivation to do so. Bidding competitions are structured to enable potential suppliers to reveal their types, or at least some approximate information related to their types. The risk averse supplier would pad its bid with insurance it needs to protect itself against risk, and this increases buyer's acquisition cost. The buyer is again forced to strike a balance between selection risk with its attendant insurance padding, and the reward it may obtain by selecting the more efficient supplier.

As a consequence of risk premiums attached to the bid, the revenue equivalence result breaks down for risk averse bidders. The variance in estimated bids, or the amount of selection risk is not the same for various reverse auction types. The inflator factor for equilibrium bids that do not induce revelation increases the variance (by square of the multiplier). In other words, the additional task of estimating the distribution of non-revelation bids introduces additional selection risk. Therefore, second price auctions have a lower risk premium than first price auctions and would lead to a lower expected acquisition cost.

11.4 Bidding Strategies (Advanced topic)

Particularly relevant to sourcing scenarios that come later is the analysis of vendor bidding strategies for various award types. The solution concept that yields these bidding strategies is the symmetric Bayesian Nash equilibrium. We can characterize bidding strategies encountered in specific types of reverse auctions of this book in different forms. Perhaps the simplest form is as a function that relates private type information to a bid. This form is restrictive, as it requires assumption about distributions and utilities, which of course are necessary for numerical computations at the design stage. Proxsys® uses uniform and normal distributions for the most part and CARA utilities. A more general form is a distribution representation, as a ratio of expected utility integrals. Specific numerical values can be computed when the analyst decides which distributions apply for the particular bidding environment. Perhaps the most general form for an intuitive understanding of bidding strategies is the conditional expectation form.

Conditional Expectation Form: The argument below represents a typical vendor's logic for its equilibrium bid. The argument set out below provides an example of symbolic representation used by authors to make the exposition precise for quantitative analysis. Reference to Exhibit 11.1 will help.

Of B potential bidders, only n actually bid. We focus on the j^{th} of n bidders, who has a cost estimate denoted by s, and who bids a price Y. Let F(.) be the probability distribution function of s. We place bids of the remaining n-1 bidders in ascending order. Of these n-1 bidders, the $(k-1)^{th}$ lowest bid is $Y_{(k-1)}$, and the k^{th} lowest is $Y_{(k)}$. These remaining n-1 bidders are constrained to use a symmetric bidding strategy, which is a function of their cost estimate, i.e., their type. Also relevant is whether on not the number of bidders exceeds the number to be selected as suppliers, i.e., n>k.

The conditional expectation over the cost probability distribution F(s) shows how the equilibrium bid is related to the expected k^{th} lowest bid, conditional on the vendor's private information. The conditionality on the vendor's cost depends on how the reverse auction award price changes.

1. The second price uniform or Vickrey $(k+1)^{th}$ reverse auction has an equilibrium bid given by the expected k^{th} lowest bid price, conditional on this

being equal to the vendor's private cost. A shorthand symbolic representation is: $E[Y_k | s = Y_k]$.

2. *The first price uniform or competitive price reverse auction has an equilibrium bid given by the expected* k^{th} *lowest bid price, conditional on the vendor's private cost being bounded by the* $(k\text{-}1)^{th}$ *lowest and* k^{th} *lowest bids. A representation is:* $E[Y_k | Y_{k-1} < s < Y_k]$.

3. *The first price discriminatory or pay-as-you-bid reverse auction has an equilibrium bid given by the expected* k^{th} *lowest bid price, conditional on the vendor's private cost being less than price. A representation is:* $E[Y_k | s < Y_k]$.

4. *The second price discriminatory or totem-pole reverse auction has an equilibrium bid given by the expected* k^{th} *lowest bid price, conditional on the vendor's private cost being equal to the* $(k\text{-}1)^{th}$ *lowest bid. A representation is:* $E[Y_k | s = Y_{k-1}]$.

Whatever the reverse auction type, expected payment by the bid taker prior to the bidding competition is the same. This is necessarily so since expectation of the equilibrium bid is taken over uncertainty in vendor cost, for the unconditional expectation. The symmetry condition holds prior to the reverse auction, since bidders have not learned their private cost estimates, s. The expected payment is, therefore, represented by $k.E[s_{(K+1)}]$. This is the famous *revenue equivalence* result for risk neutral bidders.

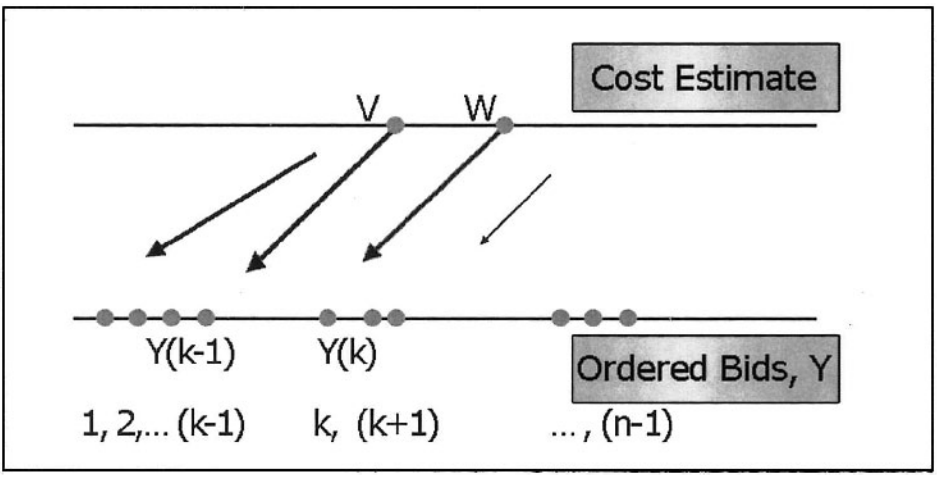


Exhibit 11.1: Ordering of Bids and Bidding Strategy. Excluding the j^{th} bidder, the (n-1) remaining bids are arranged in ascending order. The equilibrium bidding strategy relates a bid to each seller's cost estimate.

11.5 Proxsys®: Price-Quality Indexes

This section refers to the link of the same name on the welcome page of the academic software included with this book. You (as the buyer) must evaluate the vendor's response to the RFI and the RFQ. The Price-Quality Indexes that achieve this are accessed from the link on the Environment Indexes panel. The Relative Perceived Price-Quality chart is schematically depicted in Exhibit 11.2. Each supplier has a star located on the chart.

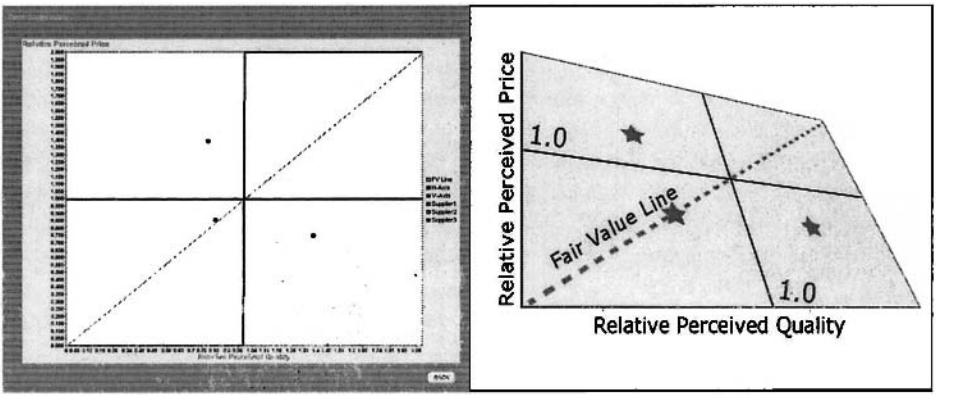


Exhibit 11.2: The Relative Perceived Price-Quality Chart. The Proxsys implementation is shown alongside a schematic diagram that highlights the main axes of the chart.

The vertical axis is relative perceived price. This is the supplier's average price divided by the RFQ average price. A low priced supplier is below 1.0 and a higher priced supplier is above 1.0. As weights are used in the averages, this is a perceptual index measure. The horizontal axis is relative perceived quality. This is a similar ratio with the weighted average quality for a supplier divided by the RFQ average quality. A lower quality supplier is below 1.0, and a higher quality supplier is above 1.0. Clearly, a supplier who is low price and high quality will be located further along the lower right quadrant.

A line that represents the Fair Value Line is marked on the chart. The FVL is the tradeoff between price and quality. It represents the perception of a justifiable increase in price for a correspondingly higher quality. When both price and quality were rated as equally important, the line is at 45 degrees. When price is more important the FVL is flatter. The buyer can judge the value of the supplier's offering by estimating the vertical distance from the FVL. Locations right of the line are favorable, and on the left are unfavorable. The buyer can use the chart in a variety of ways. For instance, it provides

- A summary of the price-quality tradeoff
- Insights into supplier capabilities

- The possibility of modifying the RFI for an improved RFQ
- Relative evaluations of supplier offerings on both key dimensions
- Elimination of suppliers below a quality threshold, or above a price threshold
- Determination of long run market shares of suppliers
- How supplier positioning along specific attributes influences overall evaluations
- How perceptual weights determine overall evaluations
- Comparisons between RFQs.

Comparision of proposals for computerizatrion of executive training at a major University			
Qualitative considerations on proposed features			
		Proposal MetaSys	Proposal Mantissa
Total Scores		97	84
Modules	Front tier		
Operations		***47***	***52***
Databases	Internal Clients	3	5
Process automation		3	5
Course & Proposal development		5	5
Academic calendar		5	5
Scheduling		5	5
Program tracking & operations		5	5
Resources management		4	5
Reports		4	5
Analytical MIS		3	5
Honorariums		5	2
Budgeting		5	5
Customer relations		***30***	***21***
Relationship management	External Clients	5	4
Enquiry handling		5	4
Nomination		5	4
Registration		5	4
Evaluation		5	4
Alumnus eep relations		5	1
Web system		7	3
Accounting		***20***	***11***
Payments	External Clients	5	2
Invoicing		5	2
Honorariums	Internal Clients	5	2
Budgeting		5	5

DesignArchitecture & Platform		***27***	***28***
Front tier		7	5
Business Tier		3	5
Data service tier		4	5
Data storage tier		4	5
Client server architecture		4	5
Data backup		5	3
Development		***48***	***75***
Multi programming multi tasking		2	5
Online interactive		2	5
Data entry updated		2	5
Sharing of files		5	5
On line help		2	5
Code tables data entry accuracy		2	5
Read only protection		2	5
Search facility -data & index		2	5
Merge form letters		2	5
User logs		5	5
Task scheduling		4	5
Access & security streamlining		7	5
Engines proprietary		2	5
Documentation		4	5
Standard language		5	5
Credentials		***22.00***	***22.94***
Duration Weeks		5.00	2.94
Risk assessment		2	5
Quality assurance		3	5
Post implementation support		7	5
Project management		5	5
Price		***300,000***	***280,000***
Fixed price		300,000	260,000
Air travel + local travel costs		-0-	20,000

Exhibit 11.3: Example for Price-Quality chart. You can use the six non-price dimensions and two price dimension scores to graphically evaluate price – quality tradeoffs.

Based on the information in Exhibit 11.3, use the Price-Quality Indexes wizard to:

(a) Input the two price and six quality attribute ratings for the two suppliers. Remember quality attribute ratings should be converted to a scale from 1 to 10. For instance, the Credentials attribute has a maximum score of 50 and a minimum score of 5 in the table above since it has five components, each with a possible 1 to 10 rating. Therefore, a score of 22 for a supplier on the Credentials scale corresponds to an attribute index of 22/5 or 4.4 on an index from 1 to 10.

(b) Consider your assessments of the importance of the categories of quality, and input appropriate weights. The sum of weights should be 100.

(c) Decide the relative importance of price versus quality, and input tradeoff weights to sum to 100.
(d) View averages, the FVL, and the price-quality chart. What is your interpretation of the chart?

12: Sourcing Design Elements

12.0 Introduction

The most useful sourcing models are explicit about information structures such as uncertainties and information asymmetries. This chapter deals with the principal-agent model (PAM) approach that applies with varying levels of sophistication to sourcing scenarios.[1]

Sourcing decisions are made by principals and by agents in the supply chain, and are subject to risk-return considerations typical of business decisions. The role of vendor effort in reducing risk and determining final cost is tied into risk-reward outcomes. Selection processes such as reverse auctions determine payments to vendors and therefore determine their strategies. Together payments and uncertain costs determine vendor profits and define the principal-agent environment. This chapter outlines the main consideration in this environment and extends the basics of the last chapter to sourcing from risk averse vendors.

12.1 Principal-agent models (PAM)

Principal –Agent Interactions: The simplest agency model of business relations identifies two sides of a given tier, a Principal and an Agent (Bergen, Dutta and Walker 1992). The Principal has governance objectives such as rents, profits, revenues, value creation, or social welfare, and must design mechanisms that the agent will take as given. The Agent has its own objectives, such as compensation, profits, insurance against risk, opportunity costs, disutility of effort and personal value of free time, and will optimize with whatever decision variables are available at the agent level, and strategize any variable subject to competitive influences. The "agency problem" is to devise a mechanism that maximizes benefits of utility of the Principal subject to certain constraints on agent effort. Constraints are most generally of three types. First, incentives provided to the agent via the mechanism or instruments available would be known to the agent and the agent is free to choose its optimal effort response that trades of its benefits with disutility of effort; the incentive compatibility constraint. Second, utility the agent obtains from its optimal response must exceed whatever alternative utility it may be able to obtain without expending effort; the participation constraint, or individual rationality constraint, or reservation utility constraint. Finally, the buyer must identify the best way of

inducing the effort desired, perhaps though some mechanism such as an auction that selects the best agents; the efficiency constraint, or welfare constraint (see Grossman and Hart 1983; or Hart and Holmstrom 1987).

12.2 Risk, uncertainty and asymmetry of information

What are the main sources of risk for the supplier arising from the sourcing strategy itself? The supplier has to deal with acquisition cost reducing activities of the buyer as the principal; reserve value or cost reduction for better competitive bidding by rival suppliers; and with their own inabilities to fully determine private reserve value or cost outcomes for themselves. These risks influence risks in the process of winning and executing the contract. It is likely that the start of the process has symmetry between buyers and sellers with all parties equally aware of uncertainties. However, this symmetry is soon broken with particular suppliers learning their private cost estimates and the buyer learning its own reserve price, number of bidders, and other sourcing parameters. The PAM approach recognizes that information asymmetry will be used by all the parties to their best advantage in retaining or extracting rents from sourcing business.

Can asymmetric information on effort be deduced from outcomes? If so, the principal's problem of compensating suppliers who hold private information would be greatly simplified. For instance, the buyer could compensate the supplier purely on the basis of audited cost for a contract. The amount of effort the supplier has expended in cost control in this ideal world could be deduced from audited cost outcome.

However, this is rarely possible due to confounding effects of uncertainty. Audited or actual cost outcomes are only partly determined by effort, and to the large part they may be determined by uncertain events over which the supplier has no control, and which cannot be separately accounted, except at great cost. Then the buyer cannot deduce supplier effort at cost control from audited cost outcome. In addition, the buyer will not be able to deduce the supplier's "type" from cost outcome. Private information on the supplier's efficiency endowment would remain private since it would be confounded with the "luck" factor introduced by uncertainty. Clearly, separation of private information of type and effort from luck is critical for the compensation scheme to come in under budget.

12.3 Contracts and Moral hazard

Moral hazard deals with two kinds of effort related asymmetric information. One is termed the "hidden action" asymmetry and the other is termed the "hidden knowledge" asymmetry. Hidden action is usually effort that is spent by suppliers after the contract is accepted; hidden knowledge is usually some information the supplier learns about an uncertain outcome that interacts with effort after the

contract has been accepted. For instance, the selected vendor's cost estimate after the contract is won and a detailed design is developed is hidden knowledge, although everyone may have used a common estimate in order to finalize the contract.

Verifiability of effort: Effort is the supplier's time, energy and resources spent on improving its performance, whether through cost reduction or improved quality. Effort that is observed or verifiable is not a problem, since it can be directly compensated. However, very little supplier effort can be verified easily and often monitoring is impossible. In most cases cost incurred in effort has to be borne by the supplier. It is a relevant question whether the buyer can induce higher supplier effort. This is difficult to achieve, as cost incurred by the supplier in unverifiable effort can never be fully recovered.

Incentive risk: The most direct approach is for the buyer to introduce some form of risk in the supplier's compensation. Risk is reduced only when effort is expended. For instance, the buyer may set a fixed price contract where cost overruns would reduce supplier payoff, thereby introducing some risk of a lowered payoff. The supplier would spend some effort in reducing this risk. Or the buyer may use a relative compensation contract, which sets two suppliers to compete against each other for a prize, and thereby hope to introduce the vendor to a risk of losing the prize. If effort can yield an advantage to one of rival suppliers then some effort may be undertaken. Amount of effort undertaken will depend on cost of effort, and the degree to which effort reduces risk. The supplier's risk-reward tradeoff is critical in this balance. For the buyer, there is a related tradeoff. The supplier adds the insurance it needs to cover risk into its bid price, when selection through bidding precedes the performance stage. The buyer must tradeoff added insurance costs with gains from effort. There is then a selection *and* incentive risk in sourcing strategy.

12.4 Interactions between reverse auction and contracts

Most analyses of selection-and-performance incentives assume a single supplier (for example, Baron 1972; Engelbrecht-Wiggans 1987; Laffont and Tirole 1987; McAfee and McMillan 1986, 1987; Samuelson 1986). Such integrated analyses reveal interactions between selection and incentive risks. Integrated analysis is even more important for strategic analyses of multiple agent situations. There is a paradoxical result of isolated views of selection and incentive risk in multi-sourcing. The principal lowers prices through multi-agent incentive risk; but it raises prices through multi-agent selection risk. Integrated analysis provides the strategic bridge between auction and agency theory that is further explored in later chapters (Seshadri 1995).[2]

Although sourcing processes between organizations in industrial and institutional markets take on several different guises, they all have aspects of supplier selection and performance incentives in common. The first involves

competition between heterogeneous vendors seeking to be selected as a supplier of a product or service; the second involves management of ensuing performance outcomes. These phases are increasingly being viewed as strategically linked by mechanisms in common use. Implementation of advanced manufacturing technology and JIT techniques will bring about an integration in the sequence of events leading up to supplier selection with the supplier's continuing performance under changing performance requirements (Macbeth 1987 offers this prediction).

The integration of these phases requires long term contracts in which parties deliberately isolate their relationship from the external market. Some problems are endemic to management of long-term relationships. Suppliers who anticipate specification changes may "buy-in" – i.e., charge unprofitably low prices to win the contract, with expectations of "getting well" –i.e., resort to price escalation as development proceeds. An effective monopoly may be created as vendors not initially selected permanently depart from the pool of potential suppliers. Many government sourcing projects display this phenomenon as an empirical regularity since a vendor's proposals are for the entire quantity the government intends to buy over the system's life span of 20 years or more, but only the initially funded few years are bid competitively. Subsequent orders have to be placed with the same supplier in what has effectively become a noncompetitive situation. Cost targets are almost invariably renegotiated at higher levels (Gates and Miller 1985).[3]

12.5 Matching selection and incentive risk-reward tradeoffs

An evolutionary biologist once said: "It is not trivial that the body knows that it should locate an eye-lid in the skin where it locates the eye in the head." In a similar vein it is not trivial that the sourcing strategist knows what the right degree of risk is for a sourcing to correspond with a particular budget on reward. Suppliers are businesses with their own determinants of risk and reward. Banks they take credit from, their own suppliers, their internal rates of return targets on capital employed, and similar business measures influence their decision making. These will determine their ability and preferences for risk bearing, and generate rent and reward seeking behavior. In turn, the buyer is an independent business with its own risk-reward behavior with respect to the specific sourcing that brings the two parties together. The match between risk-reward behavior of the supplier and that of the buyer is critical to successful sourcing strategy.

The sources of mismatch are many when buyers independently set acquisition cost targets and suppliers independently set list prices. Analyses must determine whether and under what terms rewards for suppliers will be sufficient for entry into risky and uncertain sourcing; and analyses must equally determine buyer risks of non-strategic sourcing and rewards of lowered acquisition costs. Splitting the requirement where possible through multiple sourcing succeeds in adjustments to tradeoffs for both buyers and sellers. The additional degree of

freedom when contracts can be multiple sourced enables different and more appropriate combinations of effort, type and luck. The reader will appreciate the role of multiple sourcing in rebalancing risk-reward tradeoffs for both sellers and buyers.

12.6 Sourcing systems

We apply concepts discussed in this chapter and the previous one to specific decision processes in sourcing, with each subsequent chapter focusing on a distinct scenario. Previous chapters in Part 1 have explored the influence of a variety of structural, cost, information and award considerations. Yet design of sourcing strategies must grapple with questions on relative magnitudes. For instance: what is the relative importance of opportunity costs, production costs, investments, effort costs, and selling costs? Subsequent chapters describe interactions between buyers and sellers as games, where strategies account for actions, uncertainties and information structures inherent in the sourcing process. Models differ on key dimensions of risks and incentives, and on origins. Exercises derive from each chapter, and an academic software program, Proxsys® - Procurement Expert and Strategic Sourcing System- further reveals the qualitative-quantitative trapeze act in sourcing strategy design.

12.7 Proxsys®: Risk Profile

You can access this wizard from the welcome screen; it helps determine the risk attitude of the supplier. You are asked to put yourself in the shoes of the supplier. The risk wizard presents you with options that compare a risky situation represented by an auction, with a riskless situation represented by a spot market. You are asked to determine the spot market profit that would make you indifferent to whether you opt for spot market or for an auction approach to pricing the contract.

The auction parameters are fixed. These are (a) probability of winning the auction as a percent; (b) the reward in $millions of winning; (c) up front investment in $ million that you could lose if you lose the auction. These numbers can be changed if you so choose, by entering in new numbers. You are then expected to fill in the number that represents your indifference profit with the spot market. The wizard then uses this profit to derive the vendor's risk aversion parameter. Derivation is based on the Pratt-Arrow measure of risk aversion. The best argument is for a risk aversion that is constant over the range of risky outcomes.

Consider the five risky sourcing situations faced by a supplier in the table below. The last column is the supplier's indifference profit from its alternative

spot market business. Use the Risk Profile wizard to verify that average risk aversion parameter (lambda) for this supplier is .63.

Scenario	Probability of a win	Profit from a win ($m)	Investment Loss ($m)	Indifference profit from spot market ($m)
1	.3	.1	-.01	.0224
2	.3	.2	-.01	.05
3	.2	.1	-.02	.0034
4	.4	.3	-.05	.0805
5	.15	1.0	-.1	.025

13: Risks and Rewards of Multiple Sourcing

13.0 Introduction

Most sourcing strategy recommendations are somewhat arbitrarily restricted to single sourcing. Yet multiple sourcing is more the norm than the exception. Multiple sourcing, splitting of an order among multiple sellers, occurs when buyers ensure that several bidders share the contract. The buyer may also procure from different suppliers in turn, rather than simultaneously. This chapter demonstrates how multiple source selection decisions affect sellers and buyers tradeoffs between risk and rewards in business procurements.

The chapter deals with two shortcomings in strategic recommendations for sourcing. One is due to a popular misconception of entry decision timing, that symmetric suppliers know the number of competing rivals when they make their own decision. This is clearly self-contradictory. Our strategy deals with considerations that impact the decision process, with a special emphasis on the sequence and timing of information and decisions.

A second shortcoming is due to a myopic view of buyer concerns that ignores the objective of capacity building in the supply base. Concern with supply base capacity is an essential ingredient of strategic thinking. The non-strategic approach is to stop with a search of offerings on the spot market. Strategic sourcing aims at improving on this myopic view. Multiple sourcing affects the likely number of bidders and therefore affects long term supply base capacity. We begin with an illustration of the basic process for a typical company in a typical scenario.

13.1 The Buyer A Case

A sourcing scenario helps to illustrate the significance of the sequence of decisions. Buyer A wants to standardize its word processing system company wide and is looking for suppliers. Assume there are twenty five potential suppliers. Buyer A puts out a RFI and ten sellers respond by ordering copies of it. The number of potential bidders is therefore ten. Remaining sellers (whom we call non-strategic sellers) determine the price at which the buyer could award a non-strategic or spot contract. This means the buyer could pick a supplier from among those qualified sellers not interested in competing by offering to negotiate a price with one of them based on some list price or catalogue. The buyer would

choose to use a competitive sourcing mechanism, such as a sealed bid procedure, because it expects to satisfy requirements at a price lower than that it could obtain from a non-strategic seller. We call the non-competitive spot market price the buyer's reservation price.

Quasi-experimental research reveals preference for sealed bid reverse auctions

Online auctions have achieved unit cost savings of 5-40 % in items across an RFQ; with an average gross savings of 15 –20 %. The time involved has reduced dramatically from days and weeks to a few hours to progress from raw requests for information (RFIs) to a compiled and comparable set of bids (tenders in response to a RFQ).

In 2001 DaimlerChrysler held the largest single reverse auction over the internet, at Covisint, and successfully allocated over $2.5 billion in business volume.

Suppliers in an open bid process view the auction as more opportunistic for the buyer than the closed bid process. This perception existed despite any evidence that this was actually the case of a buyer behaving opportunistically.

In a sealed bid situation the suppliers are more willing to make idiosyncratic investments than in the open bid situation. The supplier's willingness to make idiosyncratic investments was captured on a 4-item scale from 1 to 7. This showed a mean on 4.5 and a standard deviation of 1.68.

Source: Jap, Sandy D. (2003) An exploratory study of the introduction of online auctions. Journal of Marketing, 69. pgs. 96-107.

Let's say the RFQ Buyer A adopts specifies that two suppliers will be awarded equal portions of the contract at a uniform price. Buyer A will not discriminate in any way between the two suppliers finally chosen. Of ten potential bidders, say four decide to bid. These four will have to make the necessary investment in capacity to propose a credible technical and commercial bid. They continue through the RFI to the RFQ. They hire the right human resources, perhaps purchase some equipment, develop a design, begin to gather necessary cost data from subcontractors, take out options on scarce supplies, and select a bidding strategy. The process of bid preparation often calls for activities, such as search for sub contractors and writing options in the supply chain. These activities come at the cost of entry, as capacity development costs. The remaining six who examined the contract but did not bid chose not to commit capacity, nor develop competencies in the sourcing business, nor devote time and effort to preparing a competitive bid. The activities reveal a bidder's identity to other similarly committed suppliers. Each of the bidders is now better able to better estimate their probability of selection and their profit at each bid price.

Once Buyer A receives and evaluates bids, bidders learn the identity of selected and rejected suppliers. The two (out of four) bidders whom the buyer

rejects make no profits from their decision to participate. Capacity they develop goes unused. However, the two selected suppliers make further contract capacity investments as necessary, fulfill the contract and then realize their profits. Those profits depend on the supplier's actual costs (not estimated costs) as well as on contract price.

Can you afford NOT to introduce reverse auctions?

United Technologies Corp (UTC) debuted internet auctions in 1997, and has held over 2,000 auctions for $1.5 billion in contracts over four years. Annual savings have exceeded over $260 million. The head of strategic sourcing organized a bidding event for professional tax service. The RFI helped narrow the list of prospective bidders to the big 5 national firms and top 5 regional firms. The detailed work requirements led to the RFQ. Historically the cost of preparing the 1,150 tax returns the company filed annually was $1.4 million. The research on requirements and writing the statement of work took ten weeks; the bidding took 45 minutes. Bids ranged from 44% below historical costs to 51% below for foreign returns. The winning bidder was 30 % below costs.

Source: Summarized from "UTC saves 30% using reverse auctions to purchase services, Bob Mueller, Purchasing Magazine Online, 20 September 2001.

What if only one seller decides to bid? The RFQ states that the buyer will select two suppliers, so Buyer A's attempt to introduce competition fails and non-competitive sourcing results. It still has several options, including awarding the whole contract to the single bidder and adding one or more of the non bidders as a supplier. If no bids are received, Buyer A would probably award the entire contract at its reservation price to one or more of the non strategic sellers.

Exhibit 13.1 depicts the process outlined above. Seller A, as the typical seller, first decides whether to bid or abstain (S1) based on entry capacity costs and expected profits; and next, what price to bid (S2) based on contract capacity costs and cost of goods sold. Buyer A, as the buyer, makes the evaluation decision (B1) based on acquisition costs after receiving all bids. We depict uncertainties and information asymmetries that comprise the incomplete information structure with the circles. We can now exploit the advantage of identifying the precise sequence of decisions and information availability for strategy determination.

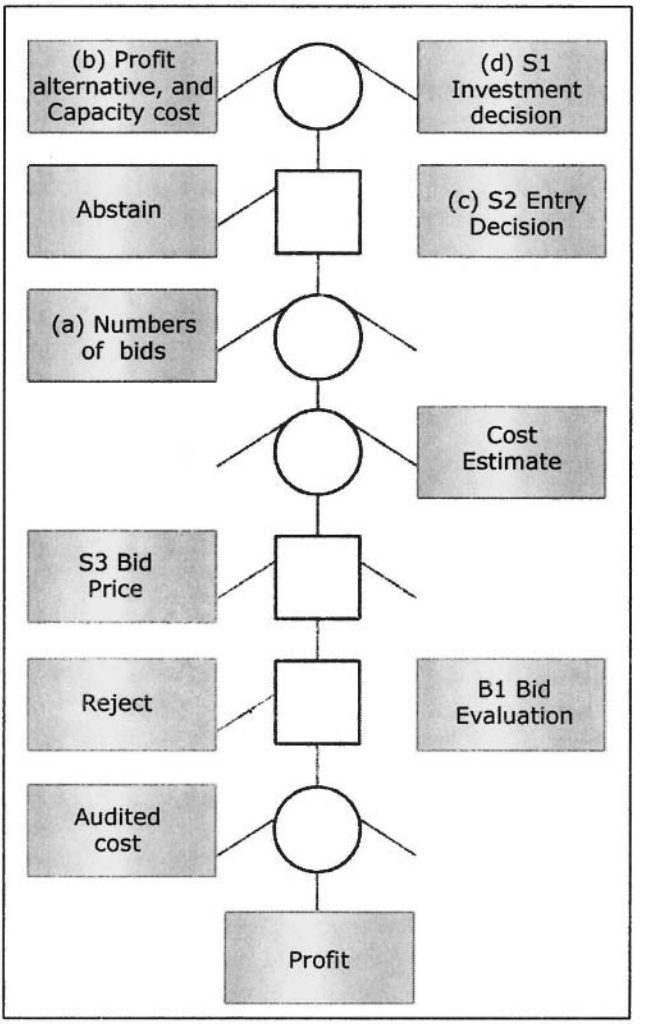


Exhibit 13.1: The sourcing decision process. The sequence of uncertainties is depicted by circles; and the sequence of decisions is depicted by blocks. Vendor or seller's decisions are S1, S2 and S3; buyer's is B1. Subsequent exhibits from 13.2 (a) to (d) capture uncertainties and expectations at different stages (as indicated here) of the decision process.

13.2 Entry Probabilities

We will investigate Seller A's equilibrium entry strategy at the point S2 in the process of Exhibit 13.1. Its expected profit depends on uncertain audited cost, and the number of bidders. Prior to learning its cost estimate for audited cost, Seller A has an estimated profit. Rolling back the estimation process, Seller A estimates its

profit prior to learning the number of bidders at decision point S2. This raises the question of how Seller A can determine the likelihood of a given number bidding, or bidding probabilities. Here all sellers like Seller A decide whether or not to bid simultaneously; this is the key to determining bidding probabilities.

Strategy Query #1- *When should the vendor enter the bidding competition?*

The relationship between multiple sourcing and the number of bidders is related to the seller's decision of whether or not to bid for a given award. The seller's decision to bid will depend in part on how much competition it expects for sourcing. What basis does the potential supplier have for knowing how many rivals it has to compete against? Note the chicken-and-egg situation here: the number of rivals emerges from the process of all possible competitors figuring what each of their opposite numbers will decide. Attractiveness of the business falls when too many competitors enter, and yet a lower attractiveness dissuades entry. The protracted and expensive process in response to a RFQ often results in a significant waste of entry capacity development and opportunity cost for rejected sellers. Need to justify an entry decision is widely encountered in almost all bidding competitions. This chapter shows how to addresses it in a quantifiable fashion (Bulow and Klemperer 1996).[1]

The decision rule sellers will use is to bid only when expected profit is no less than entry capacity reservation or new capacity development cost. The decision rule is expressed at decision point S2 as: enter and bid when estimated profit is no less than alternate profits. When other sellers are known to be using this strategy, a seller has no incentive to unilaterally deviate from using the same strategy. Thus the seller should use this decision rule as its equilibrium entry strategy, expecting to use his equilibrium bidding strategy later. Bidding strategy relates a bid to whatever estimate of cost the supplier makes when the later stage of the process is reached.

With this answer of when a seller should bid, Seller A can derive bidding probabilities of its rivals. If Seller A's estimated profit is greater than any feasible value of its opportunity cost or alternative profit, i.e., its capacity reservation cost, Seller A and all its rivals will bid. In this case the buyer has made the sourcing competition too attractive. The more interesting case is when prior profit estimates lies with the opportunity cost range. Each seller now views each competitor's decision to bid or not to bid as a "go – no go" binary outcome event, which yields a fixed entry bid probability.[2]

Strategy Query #2- *What is the probability of a bid from rival vendors?*

The entry probability does not require the supplier to know exactly how many other bidders are already committed to bid. This requirement has been the shortcoming of many earlier strategic approaches. We should make no implicit leader–follower assumption, and the entry probability arises simultaneously for suppliers. The buyer and sellers are able to estimate the probability of any given number of competitors as a binomial distribution based on the entry probability; and therefore estimate the level of selection risk engendered by sourcing (see Exhibit 13.2).

It is important that the level of potential competition be sufficiently high for multiple sourcing. In particular, the number of suppliers to be selected should not be too large with respect to the expected number of bidders. However, to determine the probability distribution of bidders, it still remains to estimate initial estimated profit.

Single source approaches have hidden costs

Traditional approaches ignore variability and risk and increase failure as a consequence of cost cutting efforts. What can yield the lowest long term costs? Single sourcing of a $5 part valve led to the shut down of production at Toyota when the supplier burnt down, halting the assembly of 14, 000 cars per day. Risk mitigating strategies go beyond mathematical optimization to estimate cost effects of changes in the sourcing environment. Scenarios from static to catastrophic changes help flesh out the risks. A supply chain glitch can reduce shareholder value by as much as 10 percent. Specific supplier glitches can reduce it by 8 percent.
(Source: How to build risk analysis into supply chain decision making. Supplier Selection and Management Report, 4,3, March 2004. Page 5).

13.3 Participation Risk and Reward

The vendor's initial profit expectation drives its interest in the bidding competition. At this point the vendor may not have a good estimate of its costs and all vendors are likely to be as ill informed about their private costs for the contract

Strategy Query #3*- What profit can the vendor expect before it knows its costs or the actual number of competitors?*

The earlier binomial distribution gives us the probability associated with any given number of bidders. Seller A computes expected profit at this level of competition based on its bidding strategy, and associates an expected profit. As the final step in roll back of estimated profit, Seller A estimates prior expected profit over the distribution of likely bidders. With the above results it can rewrite the initial or prior expected profit as an entry condition.

This entry condition characterizes the seller's participation risk and reward tradeoff. An equilibrium or balance is achieved in the following way: as expected prior profit from participation rises, selection risks rise as more bidders from the supply base become more probable, and competition intensifies. This reduces estimated profit, until equilibrium is reached between competition and profitability (see Exhibit 13.1. (c)).

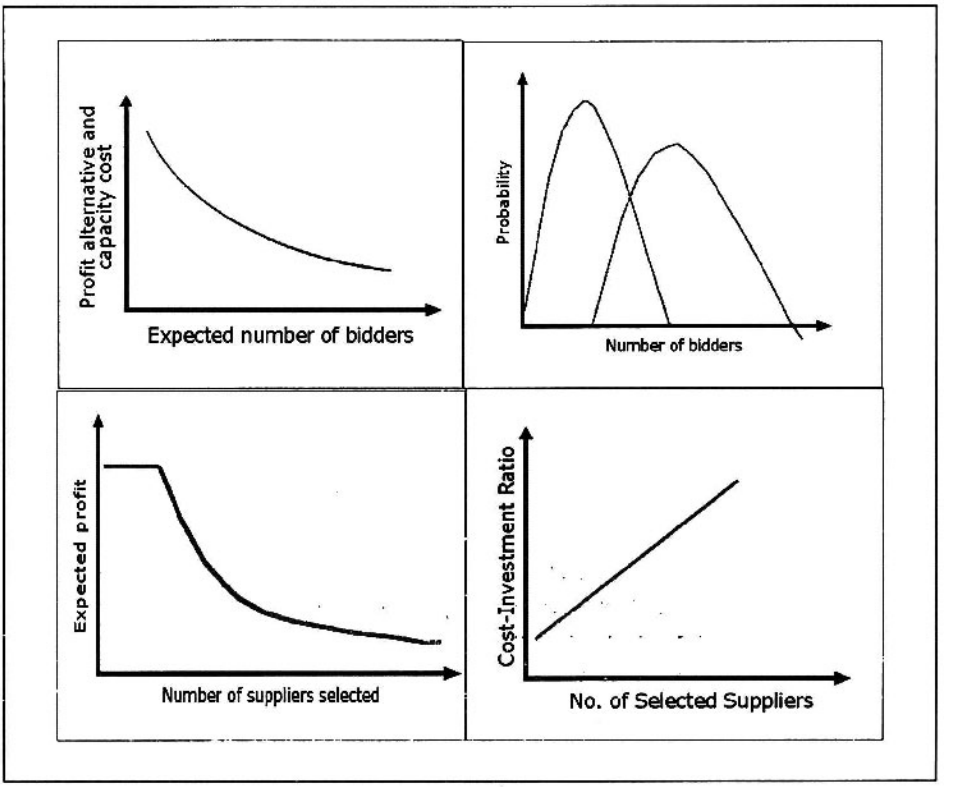


Exhibit 13.2: Entry diagnostics in multiple sourcing. Exhibits correspond to stages similarly numbered in Exhibit 13.1 above. Start from the top right and view anticlockwise. Compare this with Exhibit 13.4.
(a) Number of Bids. Probability density of numbers of bidders is binomial as a result of the equilibrium entry decision for any given number of bidders.
(b) Expected number of bidders. Expected number of bidders declines with rise in profit alternative and capacity cost, and vice versa.
(c) Expected profit. Expected equilibrium profit prior to entry. Boundary conditions imposed by the number of suppliers selected (truncated at the lower end), and the ceiling on potential bidders (truncated at the upper end).
(d) Cost-Investment ratio. Relative investment is the ratio of possible investment in capacity to acquisition cost. The ratio rises with number of selected suppliers.

Why is the entry equilibrium condition important for strategy? Big questions for buying processes and selling processes are captured in the equilibrium. It is of great significance to strategic sourcing since it determines in a probabilistic way, what the balance will be between competition and profitability for sourcing. For the make-or-buy decision buyers are concerned with the probable numbers of bidders from their supply base. For the entry decision sellers are concerned with whether sourcing is attractive enough given their alternatives, and are keen to estimate intensity of competition they are likely to encounter. The demand and

supply sides balance. These two views on the competition-profitability or risk-return tradeoffs must match for both buyers and sellers to find sourcing auction and contract design self-enforcing (i.e., in equilibrium). Entry equilibrium relates and balances all these concerns. The balance achieved by the entry condition leads naturally to the buyer's acquisition cost.

13.4 Acquisition cost

The buyer's cost of sourcing, called acquisition cost, is its total payment to all selected suppliers. Clearly the buyer is interested in keeping this as low as possible, and certainly lower than the spot market price.

***Strategy Query #4** - On what does the buyer's total acquisition cost depend?*

This acquisition cost depends on the specific contract and the number of bidders. If sourcing fails to attract sufficient numbers of bidders and is non-strategic, acquisition cost rises to the buyer's reserve price, i.e., spot market price. This occurs for the unfortunate outcome the buyer's declared number of bidders that enter the sourcing competition does not exceed the number of suppliers to select.

What is the impact of entry outcomes on expected acquisition cost? Strategic analyses are usually silent on this question. The buyer's initial or prior expected acquisition cost consists of two terms. The first is conditional on the event that the number of bids is greater than the required number of suppliers. The second is conditional on the complementary set of outcomes that the number of bids falls short of the required number of suppliers, and that the buyer will resort to non-strategic or spot market pricing. With the binomial distribution of bid numbers and the entry equilibrium condition Buyer A is able to determine all the probabilities of these events. In the remainder of the chapter we turn to the role of prior profit expectations in capacity reservation and development investment.

13.5 Capacity costs and contract splits

In previous sections on entry equilibrium Buyer A consciously deferred examination of the number of suppliers it would select. As our sourcing design poses no artificial restrictions of single sourcing, the number may be greater than one and effects of splitting the whole contract becomes relevant. The contract may be split into even portions or unevenly divided based on some information revealed during the bidding process. We discuss uneven splits in a later chapter, and here consider equal splits of the total contract. When multiple suppliers are selected, equal split leads to each winning equal fractions of the total contract. Therefore, each selected supplier's expected audited cost of completing the contract is a fraction of the total.

Inventory Storage Capacity

Suppliers have been known to directly invest in the factories of their buyers, and bear expenses on storing inventory and integrating assembly. An instance is the manufacture of Smart Cars in France in 1994. Supplier hubs managed by third party procurement service providers create capacity for storage of inventory at the hubs at the expense of suppliers. Such capacity comes at a price, but is well worth the reduction in supply risks. Apple computers employed such hubs managed by Fritz Companies.

Sharing or pooling of inventory from multiple sources is a common practice in retailing and wholesaling. Distributor Ingram-Micro has provided safety stocky in this way... With evolving supply processes the role of multiple sources becomes more important. Daimler Chrysler's service parts division improved its service supply chain, and Subway improved its risk hedging abilities through emphasis on searching and locating alternate sources of supply globally. Decoupling enables the generic form of a procured item to be stored and multisourced, for more responsive and stable supply. Xilinx Inc dual sources programmable microchips from Seiko in Japan and United Microelectronics Corporation in Taiwan. These are stored in die banks for responses to specific programmed logic chip orders from customers such as Cisco, Dell or Lucent.

Source: Lee, Hau L. (2002). Aligning supply chain strategies with product uncertainties. California Management Review. 44,3, pg. 105-119.

***Strategy Query #5**- How does splitting the contract affect vendor capacity investments?*

The cost of capacity reservation and development investment relevant to the entry decision by potential suppliers is a corresponding fraction due to contract splits. Expected entry capacity developed by bidders when the contract is split is aggregated across all bidders. Recall that a bidder actually incurs this entry capacity development cost prior to the selection decision, regardless of whether it actually wins a contract, as it is necessary to maintain competencies in sourcing business.

It is possible that splitting the contract also increases the number of qualified potential bidders, some of who may otherwise have been screened out due to capacity constraints. The number of potential bidders is therefore likely to be higher.

13.6 Capacity Risk and Rewards

Strategic planning usually requires that Buyer A works to a budget for sourcing. Then the expected budget surplus is computed as budgeted funds less

expected acquisition cost. This is the short-term benefit from the particular sourcing, and the buyer is concerned about increasing this surplus when sourcing is viewed as a cost center in the firm. However, it is a myopic view to increase this surplus with short run acquisition cost reductions solely from emphasizing single sourcing and supplier profitability.

Strategy Query #6- *Are there long-term buyer benefits from splitting the contract?*

Buyer A has long-term objectives as well, and capacity enhancing sourcing is not just a costly activity but has strategic value for the firm. The need to increase capacity dedicated to sourcing business is one such key objective that has long-term implications for health of continued sourcing activities. Capacity constrained sourcing is subject to problems of stock out and steep upward price pressures as capacity utilization rises, as we see in the next chapter. The long-term strategic imperative for Buyer A is therefore to assess the benefit from supplier spending on capacity reservation and development. The buyer should structure individual procurements to enhance investment in developing capacity. These investments are total expected spending by all bidders on reservation and development of capacity by selected suppliers for entry decision.

Buyer A can now estimate aggregate expected prior entry capacity reservation. An advantage of multi-sourcing is that it improves likelihood of higher number of bidders. Additional entry capacity reservation could improve industry slack capacity. The next chapter shows the importance of slack capacity on price containment.

Buyer A's multi-sourcing strategic objective is to maximize long-term benefits, which is the sum of short-term benefits and benefit from capacity reservation and development from sourcing. Buyer A can quantitatively estimate this total benefit as the weighted sum of benefits from budget surplus and committed capacity benefits. The non-myopic buyer's capacity-price tradeoff of splitting the contract among multiple suppliers is now at least qualitatively evident.

The capacity-price tradeoff is best expressed as follows. One the one hand, a greater number of suppliers selected in parallel sourcing increases Seller A's equilibrium profit, and therefore Buyer A's acquisition cost. Moreover, the probability of bidders falling short of required suppliers increases, making it more likely sourcing is non-competitive. Buyer A's risk of non-competitive sourcing therefore increases with multi-sourcing. Moreover, advantages of economies of scale if any exist for Seller A are lost in multi-sourcing, and total audited cost is likely to be higher than single winner-take-all sourcing. Short-term budget surplus is therefore likely to fall with multi-sourcing. A higher risk and lower reward in the short-term will rule out multi-sourcing unless other considerations more than balance rewards.

On the other hand, these other considerations such as reservation of capacity for entry and development of production capacity for the contract improve with multi-sourcing. The risk of stock out falls and added capacity in sourcing business

has long-term downward pressure on price. This is especially so if diseconomies of scale apply. Increase in investments may more than balance increase in acquisition costs, if Buyer A realizes long run benefits.

E-sourcing is better business...

A major manufacturer of consumer products budgeted $700 million for purchasing through their reverse auction process. A personal care manufacturer save $7 million through the use of e-sourcing tools, with e-sourcing that impacted cycle times and overall professionalism. An agrochemical producer achieved over 10 percent savings with e-tendering tools. A financial services firm saved over 40 percent with e-RFX tools.

Source: 4 essential steps to running effective e-reverse auctions. Supplier Selection and Management Report, 3, 11, November 2003. page 1.

... and the awareness is growing

e- sourcing processes are showing an upward trend. A recent survey showed that since 2000 the practice has risen by 10 percentage points. About one in five buying firms in the US is currently doing e-sourcing. Diagnostic tools that help increase visibility across business units reveal opportunities for better sourcing practice.

Source: Supply management best practices reflect "get tough" attitude. Supplier Selection and Management Report. 3, 10, October 2003. Page 15.

The optimal degree of multi sourcing balances marginal costs from an additional supplier with marginal gains. Insights from this chapter, on the probability distribution of number of bidders, equilibrium entry equation and buyer's long and short term cost-benefit tradeoffs, together allow Buyer A and Seller A to balance key initial or *a priori* risk-reward tradeoff concerns from both points of view, buyers' and sellers', as they design their sourcing processes. The acquisition cost-to-investment ratio may often be less than unity implying that benefits may exceed costs (see Exhibit 13.1.(d)).

The multiple sourcing strategy is now fully characterized by capacity reservation and development, entry decisions, probability of any given numbers of bidders, biding strategies, expected profits, expected acquisition costs. Sourcing analysts from Buyer A and Seller A can quantitatively calibrate strategic parameters to determine supplier tradeoffs between profitability and competition, and buyer tradeoffs between acquisition expenses and capacity benefits.

Such calibrations based on the entry equilibrium condition are reassuringly similar to findings from empirical studies. In an effort to empirically quantify tradeoffs, researchers developed a multiplicative model relating average contract price to quantity bought, capacity utilization, whether the buy was a noncompetitive sourcing, winner-take-all competition, or dual source competition (Greer and Liao 1986). Their empirical results support all our strategic

prescriptions on price-capacity tradeoffs, and show that lower capacity utilization rates lower bid prices. A single source price at a higher CU may exceed a dual source price at a lower CU (see Exhibit 5.1).

Capacity in the supply base

Because of low revenues flash managers did not invest in capacity. Upshot: higher prices. Spot market prices for 16 Mb TSTOP flash chip increased from about $10 in the first quarter to $ 28 in the fourth of 1999. *Source: Chip market tightens. Allocations already begin. Buylines www.purchasing.com Nov 4, 1999. Pg 32.*

Motorola's sourcing strategy for capacitors was to have three suppliers. One performed best in ceramic parts, one in tantalum parts and one in both. Business could quickly be shifted. The Motorola commodity team adjusted shares of business based on supplier ratings. The strategy prompted high competition in quality technology, delivery and pricing, and provided administrative simplicity. *Source: Ken Stork, www.purchasing.com Nov 4, 1999. Pg 32.*

13.7 Multiple Sourcing, Capacity and Bid Prices

Strategy Query #8- *Are the supply base's propensity and potential to compete affected by multiple sourcing?*

The supply base's *propensity to compete* is inversely determined by capacity commitment costs or capacity utilization. The *potential to compete* is determined by the maximum number of qualified bidders. Multiple sourcing increases the propensity to compete, and improves upon industry slack capacity through entry capacity development spend.

In addition, selected suppliers invest in contract capacity spend. Overall capacity benefits are often substantial. The buyer's objective is to insure against sudden surges in demand. Greater bidding probabilities under multiple sourcing imply that more vendors will invest in entry capacity to seriously compete in bid sourcing. This insurance for the buyer comes with increase in bid prices per individual sourcing. If the long run includes stock-out penalties for the buyer, then there is a long run justification for multiple sourcing.

The *propensity to compete* is determined in part by opportunity costs. The distribution of alternate profits, of the seller's reserve price or opportunity cost, is a proxy measure of capacity utilization (CU) rates. As CU rates rise, this distribution shifts to higher values, and fewer bidders become more probable (Greer and Liao 1986).[3]

The second crucial element, the industry's *potential to compete*, is determined by the number of potential bidders who comprise the pool of interested sellers

able to make strategic bids. The entry equilibrium equation highlights its importance. The non-strategic focus has usually been on a given number of bidders as assumed participants, and this can be a misplaced focus. Textbooks have noted quite early that "procurement managers will strive hard to avoid specifications that de facto result in sole source or limited competition." (Webster 1984, p.177). This may be accomplished by writing broader specifications that allow more potential bidders to qualify, and by taking a long-term view that encourages multi-sourcing.

SAP® on e-sourcing

A SAP White Paper emphasizes the problems in practice that a supply base of multiple suppliers is likely to handle better.

Stock outs in the European automotive market responsible for about Euros 5 billion could be reduced with appropriate e-procurement transitions from Push to Pull. Poor performance results from the difficulties in materials, capacity and production planning. A supply base with built in flexibilities becomes all the more important.

The paper expects there to be just 10 major OEMs left in the automotive business who buy globally from e-procurement hubs. In 1990 the world-wide average capacity utilization was 90 percent; and in 2000 it was 69 percent.

E-tendering and supplier integration over internet links is growing and becoming a central part of start-up business cycle shortening. Optimizing time is expected to reduce the cycle to full production by a quarter, and this translates to hundreds of millions of dollars in discounted future profits.

What does it mean to collaborate in the supply chain? The aim is to optimize the 60 percent contribution to value of the supplier. The decentralized supply chain is a necessity as you go further upstream the share of supplier business falls to a negligible amount for any given OEM. Though control may be arguably desirable at a centralized level it is unlikely to happen.

Procurement is governed by a master agreement that certifies supplier who follow the buyer's general business rules on logistics deliver and standard process. The specific purchases are bid within this master agreement on basis of timely need.

Source: Managing the e-supply chain in the automotive industry: Processes, structures and solutions. Volume 1. MySAP.com.2000.

When sourcing is green field, multi-sourcing is often used in phases to accomplish these objectives. For instance, a green field sourcing operation for manufacture of electrical home appliances in an emerging market by a major European multinational corporation used two phases. In a first phase, ten suppliers were selected and multi-sourcing led to significant capacity

development. Based on satisfactory entry and contract capacity among the supplier base, a second phase several months later reduced the number of suppliers to three.

Multi-sourcing and know how

A survey of modular buying across multiple countries in the telecommunications vertical showed that know how is critical in the decision to use multiple suppliers. As the buyer's know how improves from a very poor level to a moderate level, its preference for single sourcing falls. Plausibly, the buyer is better able to discriminate and mix multiple suppliers' offerings. As its know how grows, the study found that for high know how buyers the preference for in-house sourcing rises dramatically, and the preference for single sourcing over multi sourcing again rises.
Source: Stremersch, S., Weiss, A.M.,, Dellaert, B.G.C., and Frambach, R.T. (2003). Buying modular systems in technology-intensive markets. Journal of Marketing Research. Vol XL, 335-350.

We can see that the entry equilibrium equation solves the chicken-and-egg problem of which comes first: the decision to bid or the number of bidders. The best way to put it is that what comes first is a probability distribution of the number of bidders. A fixed-point solution to the entry equilibrium equation determines profitability and hence probabilities of bidding and the number of bids. This is a different answer than saying that the number of bidders will increase until there is fixed zero-economic profit from sourcing. If economic profits are going to be zero then what is the firm's incentive in the first place to participate in sourcing business? (Rogerson 1989). The only direct answer is given by the entry equilibrium condition. The firm can expect to make a real positive economic profit that can be calculated from this strategic condition.

13.8 Conclusions

Vendors have higher expected profits when the buyer selects more suppliers in a multiple source competition. Then more bidders are likely, leading to higher investments in supply base capacity. However, acquisition costs increase with more selected suppliers. The risk-return tradeoff for buyers that this chapter identifies depends crucially on the advantage to the buyer of capacity development, a specific outcome of multi-sourcing. We discuss the dependence explicitly in the next chapter, which addresses the specific impact of capacity constraints on price containment.

There are possible limitations to use of the fixed price multiple source awards as discussed in this chapter. Constraints arise due to (a) the buyer's ability to split the contract into perfectly substitutable unit contracts depending on the desired

number of selected suppliers, each of whom get one unit. Equally, the buyer must be able to reintegrate the offerings from suppliers. (b) The ability of suppliers to estimate their alternative business to make the entry decision; and the buyer's ability to determine distribution of these alternatives to make sourcing sufficiently attractive. (c) The capacity available from a supplier for the contract is too small, or even below the requirement for the unit contract. (d) Suppliers are not risk neutral. (e) Cost estimates are very uncertain and cost sharing is likely to reduce prices. (f) Suppliers more interested in short run profitability than in building capacity with investment in sourcing business from multiple source profits. (g) Insufficient interest or budgets on the buyer's side for supply base development, and a myopic short run emphasis to come in under budget. These constraints require other sourcing designs dealt with in subsequent chapters.

Inventory smoothing and split orders

Splitting orders can bring reductions in inventory holding costs and shortage costs that outweigh incremental ordering costs. With transportation costs included the advantage of dual sourcing is eroded, but unreliable lead times, short supply lines, high value items and high shortage-to-holding cost ratios favor dual sourcing.

Source: Tyworth and Ruiz-Torres (2000).

Among the methods of reducing demand and supply variations, split orders are favorable for situations of high in-transit inventory costs and transportation costs. Split orders allow partial shipments to be received at different times. It allows inventory reducing options to be employed. Order splitting leads to lead time pooling, but not to demand pooling across locations. The expectation of two summed random variables must be less than their individual expectations.

Source: Evers, Philip T. (1999).

13.9 Strategy Query Checklist

The strategy queries posed and answered here are:

- *#1- When should the vendor enter the bidding competition?*
- *#2- What is the probability of a bid from rival vendors?*
- *#3- What profit can the vendor expect before it knows its costs or the actual number of competitors?*
- *#4 - On what does the buyer's total acquisition cost depend?*
- *#5- How does splitting the contract affect vendor capacity investments?*
- *#6- Are there long-term buyer benefits from splitting the contract?*
- *#7 - How can we quantify the benefit – cost tradeoff for multi-sourcing?*
- *#8- Are the supply base's propensity and potential to compete affected by multiple sourcing?*

13.10 Proxsy®: Fixed Price Contracts

The opening screen presents you with the Exercises drop down menu. Select Fixed Price Contracts and begin the tasks. A description of how you may use the screen in Exhibit 13.3 is contained in Help.

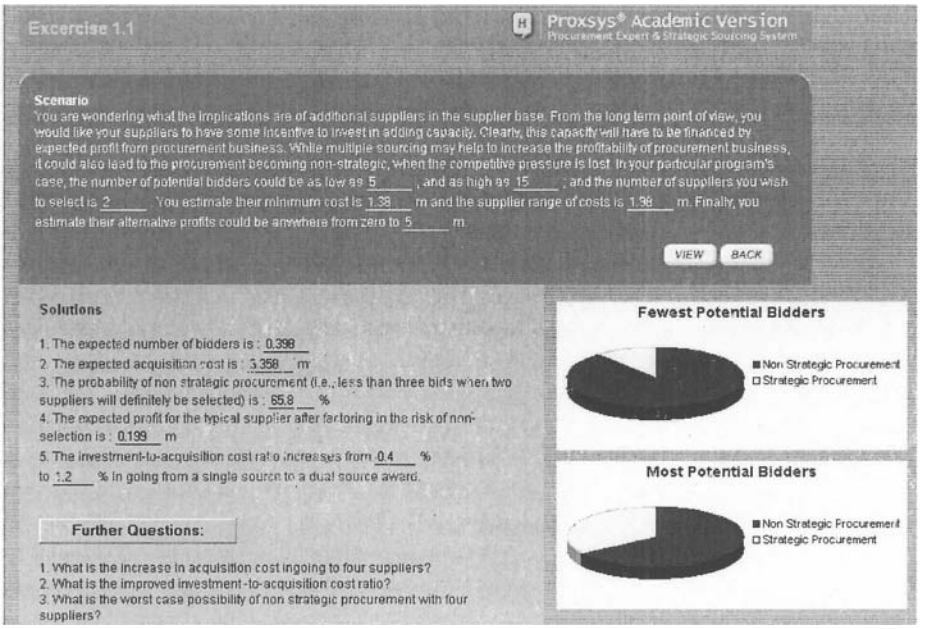


Exhibit 13.3: Exercise 1.1 on Fixed Price Contracts. Data is picked up from the Sourcing Indexes but you can make changes in the scenario. You then view the basic solutions.

Exercise 1: Use the Fixed Price Contracts design scenario to demonstrate the following results. Let us say the buyer wants to dual source with a Vickrey fixed price award. Say the sourcing analyst determines (perhaps subjectively) that seller's cost estimates are uniformly distributed with a lower extreme of $1.38 million and a range of $1.98 million. The potential number of bidders is as low as 5, but could be as high as 15. The cost of capacity reservation or alternate spot market profit from capacity that would be tied up is also uncertain and ranges fro 0 to $5 million. The report is for the pessimistic case of 5 potential bidders. Expected acquisition costs, expected number of bidders, and expected profits vary non-linearly as determined by calculations across the range of possible values. The reports show how the results vary with uncertainties, or risk analyses.

Exercise 2: In a slightly different calculation the number of potential bidders varies, say B increases from 1 to 15. The single source award yields expected

acquisitions costs that fall. Correspondingly, the dual source award yield falling acquisition costs. Clearly, the buyer incurs non-strategic expected acquisition costs when the number of bidders is one for single sourcing; and is less than or equal to 2 for dual sourcing.

Further Questions: Follow the links and view the graphical reports for a variety of risk analyses. Compare the reports depicted in Exhibit 13.4 with the schematics of Exhibit 13.2. In particular, observe how the distribution of the number of bidders changes with the input range and indexes.

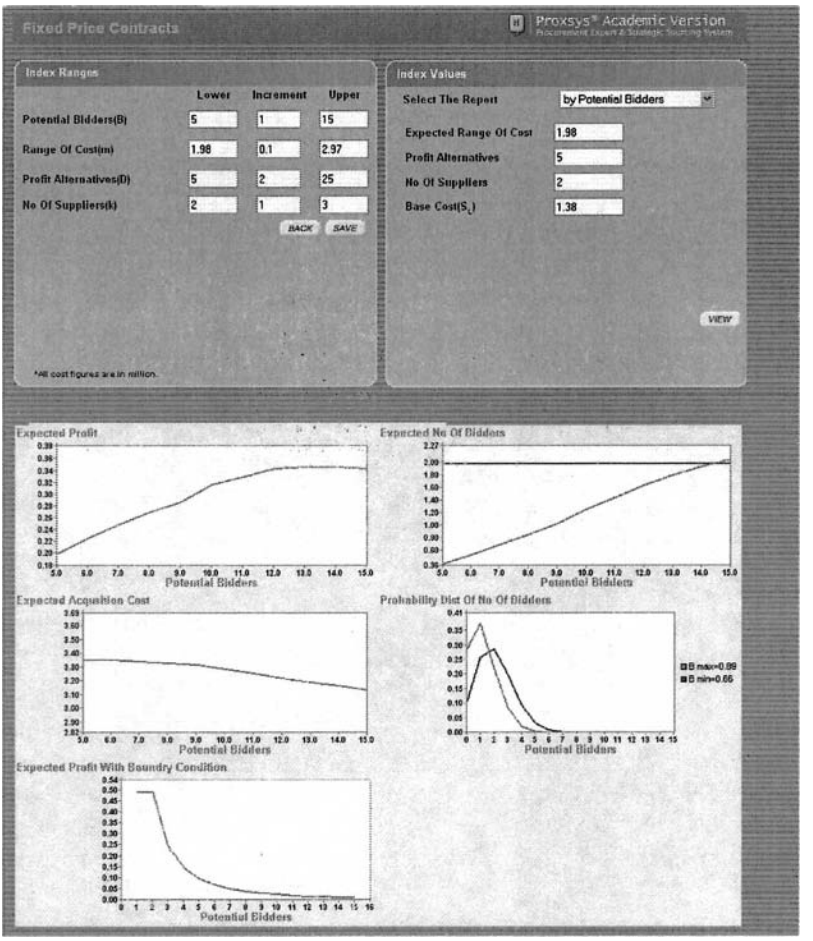


Exhibit 13.4: Further Questions on Fixed Price Contracts. Data is picked up from the Sourcing Indexes but you can make changes in the scenario. Compare with Exhibit 13.2.

14 : Capacity Constraints and Pricing

14.0 Introduction

A supplier, such as a microelectronics components company Supplier B, can usually access spot markets. However, it contracts on the sourcing market with given buyers as well, such as Buyer B, who may be a value added reseller in the computer electronics industry. Both companies know that the recurring demand in this spot market is volatile and unpredictable. Parallel markets of this sort are very common. Yet most strategy recommendations maintain the fiction of dedicated suppliers for a single buyer. The distinction is important when there are joint costs that suppliers allocate when producing for parallel markets, as we discuss in later sections. [1]

Also, in this scenario buyer and suppliers know that there are capacity constraints that govern availability of components from each supplier in the supply base that includes all rivals of Supplier B. As a capacity constrained supplier, Supplier B is concerned about the appropriate way to price its products relative to its capacity utilization, and seeks to optimise tradeoffs between contracted sourcing and the spot market. As a buyer, Buyer B is concerned about the best types of bidding and award procedures to adopt and whether sourcing should be split into re-procurements and multisource procurements in order to manage supplier capacity utilization effects on sourcing costs. How should this sourcing relationship be governed? What are bid-contract options and how should the buyer determine quantities, number of suppliers, and booked capacity? This chapter addresses these decisions.

The previous chapter has demonstrated the criticality of supplier capacity utilization. Yet surprisingly few recommendations have hitherto been forthcoming on how to increase or manage capacity of the supply base for sourcing business. One thing we know from our discussed principles is that the extent of demand, relative to capacity available to satisfy that demand, is a determinant of the optimal pricing mechanism. We can reasonably conclude from these principles when Buyer B's potential demand does not exceed capacity of suppliers, the optimal pricing scheme among all classes of pricing schemes is a version of the second price Vickrey reverse auction (Harris and Townsend, 1981).[2] This is *good news*, as Seller B and Buyer B are both familiar with common bidding processes and will likely use some reverse auction procedures.

Supplier Slack Capacity

With rapid growth at over 40 percent a year, and high demand volatility it is imperative that suppliers be flexible and agile in capacity to match growth. A single firm's demand cannot represent a disproportionate amount of a given supplier's capacity. Michael Dell's own words are lively, but his principle with capacity planning is simple. Three-year capacity plans with suppliers are necessary, and it is important to know how much capacity the firm is consuming with their current suppliers. It is catastrophic if the particular mix required of, say monitors, changes and the existing capacity with current suppliers is short of the demand.
Source: Direct from DELL, by Michael Dell. Pp. 179-80. HarperCollins Publishers Inc., New York. 1999.

How can bid processes help the selection, allocation and pricing of capacity requirements? Our intuition is that price depends on numbers of selected suppliers, marginal costs, capacities and uncertainty of the sourcing environment. Suppliers with capacity constraints such as Supplier B will have reserve prices for sourcing that increase with a specific buyer's sourcing requirements, based on how much they buy from a given supplier.

The buyer then is faced with each vendor's reserve price-capacity "supply curve." This supply curve is an opportunity cost curve, distinct from the usual aggregate quantity, multiple bidder supply curve. It is due to the fact that any supplier can sell in parallel markets through alternate channels.

The opportunity cost need no longer be the mysterious quantity of simpler bidding strategy analyses. Supplier B, the capacity constrained supplier, is particularly interested in unbundling its opportunity costs. The price-capacity supply curve does this and relates it to bid pricing. We will see that unbundling of opportunity costs has the advantage of revealing additional advantages for Buyer B of fixed price approaches over incentive contracts, as well as those of multiple sourcing over single source arrangements. In this chapter we elaborate on use of reverse auctions in a parallel market capacity constrained scenario. This situation is ubiquitous in modern sourcing programs.

14.1 Multi-market capacity-price strategy

Parallel markets provide more than a single channel for buyers and vendors to buy and sell capacity (Elmaghraby 2000; Malone, Yates and Benjamin 1987).[3] Markets are generally either spot markets with list prices, or sourcing markets with reverse auctions and price discovery. Vendors face the challenge to price capacity appropriately in each market, balancing spot versus sourcing market costs and benefits. The multi-market situation for the vendor changes its reserve price for entry into the sourcing market. In turn, the vendor's specific price-

capacity choices in the sourcing market will affect Buyer B's sourcing design strategies. Buyer B for instance must now additionally consider whether to use fixed price or incentive contracts, award variable quantities or equal unit contracts, decide what numbers of suppliers for required capacity will be optimal, and how to divide purchase requirements between re-procurements.

Chapter 13 demonstrates that multiple sourcing increases the probability of more bidders; which leads in the long run to higher dedicated capacity critical to insure the buyer against surges in demand. It identifies the buyer's price-capacity tradeoff between short-term price increases in creating slack capacity in the supplier base and long-term advantages in supply assurance and capacity utilization rate driven price reductions. This chapter builds upon this insight by explicitly determining how capacity in the supplier base affects pricing though the supplier's price-capacity curve (Hazra, Mahadevan and Seshadri 2004 elaborates on a related issues).

Transactional to strategic control over purchasing

Sunoco Products Co. developed a detailed electronic procurement system to link with its ERP. It aimed to shift its focus from a transaction to a strategic sourcing approach. In many cases, Sunoco, a Hartsville S.C., USA, based corporation, limited its suppliers for a commodity to one, but usual case was multiple suppliers. Purchasing has a centralized sourcing group and business rules govern the routing of orders to buyers in Sunoco's group.

Source: Shaw, Monica (2000). Pulp and Paper. Feb. ERP and E-Procurement software assist strategic procurement focus at Sunoco. P. 45.

14.2 Multi-sourcing and capacity

Strategy Query #9 – *Why should buyers consider reprocurements?*

Reuse of capacity will allow suppliers to meet requirement, despite constraints. Higher turnover on assets for suppliers is a desirable business objective in any case. If the buyer can stagger capacity requirements over many periods they could circumvent constraints owed to limited installed capacity in the supplier base. A straightforward way to do this is by re-procurement where the buyer uses multiple rounds of bidding and contracting of unit contracts. Multi-period auctions could be used as a tool in revenue management. Clearly, reprocurements reduce capacity utilization rates for any given period.

Many supplier selection and price discovery approaches that Buyer B might use do not account for information asymmetry between buyers and suppliers on cost, capacity and alternative business opportunities in parallel markets (Narasimhan and Stoynoff 1986; Weber, Current and Benton 1991).[4] When full

information is not available, multi-round bidding allows information communication for more efficient sourcing.

However, these multi-round procedures may not be convenient for Buyer B in all situations, and sourcing may often require one-shot bidding (You 2000; Gallien and Wein 2000).[5] Is it possible to improve on reprocurements with multiple sourcing from the capacity constrained supply base? Strategic answers are woefully inadequate on this issue though recent attention is focusing on this issue (Vulcano, Van Ryzin and Maglaras 2001). We will show how Buyer B can use strategic capacity-managed multi-sourcing for managing Supplier B's opportunity cost of capacity in a one shot award.

Strategy Query #10 – *Does the buyer gain by unbundling the supplier's reserve price?*

Supplier reserve prices: Supplier B can calculate its reserve price for the bidding competition in a variety of ways. In some fashion, the vendor includes the direct and indirect portions of fixed and variable costs associated with sourcing. A simple and appealing way is to group all direct costs as variable, and all indirect costs as fixed. Variable costs are part of production costs, and indirect costs are part of fixed costs.

One costing approach adopted by suppliers in multi-markets is to estimate total fixed period costs in both spot and sourcing markets, and to allocate a portion of that to sourcing. The argument for this is that this portion of fixed cost would be absorbed in alternate business if capacity were not reserved for sourcing business. Therefore, it is an opportunity cost of capacity reservation. Such joint cost allocations with the opportunity cost label in parallel markets can be a source of contention in audits, and is one reason why fixed price contracts are recommended. In this chapter we therefore also recommend the fixed price award, although we examine the strategic value of other awards in later chapters.

Suppliers incur selling costs while buyers incur search costs. Previous research has found that in such situations, electronic B2B exchanges reduce search costs, and size of the exchange is optimally neither zero nor infinite, but finite and stable. Sellers' prices may not necessarily decrease with lower search costs; but buyers' surplus usually increases (Fath and Sarvary 2001). In scenarios requiring capacity reservation due to capacity constraints, selling costs are relevant to supplier pricing decisions in addition to production cost, and other joint cost allocations or opportunity costs in parallel markets.

Therefore, it is intuitively evident that the vendor's reserve price varies with capacity reserved for sourcing, and a price-capacity curve ensues. Knowing the price-capacity curve allows the buyer to use capacity allocations to control its acquisition cost.

Strategy Query #11 – *Should price determine supplier quantity or vice versa?*

Price-quantity allocations: Since price varies with capacity, Buyer B has two strategic options for the sourcing program's price–quantity allocations. One option is to determine a fixed quantity or equal unit contract based on price-capacity considerations and use the reverse auction to find the price that yields the

required number of suppliers. The sum total of multiple unit contracts should satisfy Buyer B's total capacity requirement. It awards each selected supplier with an equal single unit contract of fixed quantity at the uniform market-clearing price. A second option is to fix price and determine the quantity that each supplier will supply at that price, based on the vendor's price-capacity curve. Either way, the sum total of each vendor's quantity should satisfy Buyer B's total requirement, what we can term "market clearing."

Variable quantity allocations, the second option above, have a downside in repeated sourcing situations. Unequal splits would create non-symmetric cost structures in future periods, due to asymmetric learning, which may have detrimental effects on future competition (Klotz and Chatterjee 1995; Lee 2000).[6]

The differences between Buyer B's two approaches, the "fixed quantity – market clearing price" approach and the "fixed price-market clearing quantity" approach are depicted schematically in Exhibit 14.1. We defer discussion of which yields lower acquisition cost to a later section.

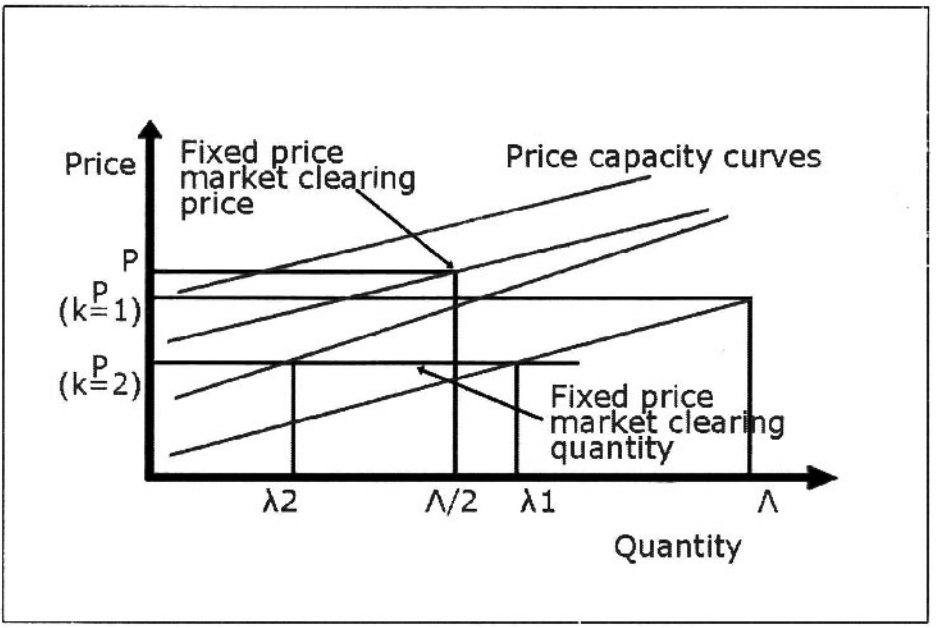


Exhibit 14.1: Reserve price –capacity curves and award types. Denote by Λ (capital lambda) the buyer's required capacity for sourcing in the program. This could be procured in one program or multiple procurements, m; if so, the buyer's total requirement is m Λ.
The script price P3 in the exhibit is award price for the lowest rejected bid, dual source, fixed quantity-market clearing price award. The fixed quantity for the dual source here is Λ/2. Price P(k=1) is award price for the lowest removed bid, dual source, fixed price-market clearing quantity award. The lowest removed bid changes the quantity allocation to two vendors from λ1+λ2 at P(k=2), to a single vendor λ_1 at P(k=1).

14.3 Sourcing and non-sourcing markets

Suppliers sell in both spot markets and with sourcing contracts, and key differences in demand and selling costs impact their pricing behavior in each.

***Strategy Query #12** – How does spot market uncertainty affect sourcing?*

Uncertain demand: Spot market price per unit of capacity is a fixed list price P, the vendor's historical average price. When a given supplier to the spot market faces a demand that does not exceed its capacity, as is the case here, the fixed price approach is optimal (Harris and Townsend 1981).[7] For situations when spot market demand is uncertain, rather than downward sloping, vendors such as Supplier B would continue to adopt the fixed price approach for a portion of capacity. Therefore, the typical supplier sells a random amount of capacity, X, on spot markets at list price P. The random nature of demand imposes a burden of financial risk on vendors. The seller's corresponding concerns outside of sourcing markets are primarily due to selling costs, uncertain demand, and inflexible list price levels.

Selling cost: Selling costs include all costs necessary to find buyers, such as costs of advertising, marketing and sales, and general administrative costs involved in customer acquisition. These can often add up to 10-15 percent of revenues.

An average selling cost function to book capacity in the spot market applies for all suppliers. The nature of this cost is such that it increases more rapidly at higher levels of booked capacity. Therefore, Supplier B incurs a selling cost, which is increasing in booked capacity.

***Strategy Query #13** – What are the uncertainties in sourcing?*

Uncertainties are different in the case of sourcing markets. Here, instead of a historical average price, there is a price discovery mechanism. A multi object Vickrey reverse auction may often be optimal when (a monopoly) buyer's demand exceeds a given supplier's available capacity for the sourcing market, as is likely the case here (ibid.). Uncertainties in sourcing markets therefore involve risks of non-selection due to competitive bids. Of course there is imperfect information on costs. Moreover, the number of competitors is likely to be different, since the sourcing marketplace has a wider reach and would certainly be able to attract non-local vendors. Selling costs in sourcing markets, especially if they are electronic markets, are much lower than those in spot markets (so also for search costs, as discussed in Bakos 1997). In sum, for Supplier B who participates in multiple markets with a finite capacity a different sets of risks and rewards prevail in spot markets versus sourcing markets.

Production cost: As Supplier B utilizes more of its capacity in sourcing contract production its total accumulated contract production cost increases. When all suppliers have access to the same production technology, unit contract production cost is very similar if not identical for all suppliers. Barring situations of cross border sourcing, when unit production costs may differ across economies, such a scenario is reasonable given large-scale efforts of suppliers in

recent times to benchmark, acquire similar technologies and best practices to remain competitive. In the sequel, we will see how price quoted by Supplier B to Buyer B in the sourcing market is a function of available capacity reservation, demand uncertainties, production and search costs, and multiple sourcing.

14.4 Supplier reserve price-capacity curve

***Strategy Query #14** – What are spot market price and capacity impacts on sourcing?*

Supplier B's decision logic unfolds as follows. A supplier will sell some capacity in the spot market at unit list price, P. However, since it faces uncertain demand and incurs selling costs, it will consider selling some available capacity in the sourcing market at a lower price. Based on these considerations, suppliers can derive their *reserve price-capacity* curve for the sourcing market.

The reserve price-capacity curve provides a basis for Buyer B to allocate capacity reservation order among suppliers so as to minimize its sourcing costs. But how will the buyer learn a specific supplier's reserve price-capacity level? It is initially uninformed on specific suppliers' reserve price-capacity curves. The most significant difference between suppliers is their capacity, which is private information. Therefore, Buyer B needs a reverse auction mechanism to achieve price-capacity discovery. The optimal reverse auction would be a variation of the Vickrey auction as discussed earlier. For the fixed quantity award, an equal single unit contract to k lowest bid suppliers, with a uniform award price at the $k+1$th bid minimizes total procurement cost. This is easily implemented. Buyer B announces in advance terms of fulfillment as a RFQ, along with reverse auction rules (such as quantity or price clearing, sealed bid, second price, duration of bid taking, and the number of suppliers sought).

Capacity reservation condition: Consider Supplier B's point of view, for a period of given duration or period where it is trying to manage its capacity utilization. Due to demand uncertainty that leads to non zero expected selling costs, it would be willing to commit part of its capacity in the sourcing market at a lower price, as it faces negligible selling cost here. Supplier B's expected total profit from such a strategy should be at least as much as when it offers its entire capacity solely on the spot market. This is the usual entry decision condition, adjusted for partial capacity reservation. Expected profit from exclusive sale on the spot market is given by list price times its expected demand truncated at its capacity; less its selling costs; and less its production costs.

So suppose Supplier B commits or reserves some units of capacity on the sourcing market for that period. Then its available capacity for spot markets is its total capacity less this reserved amount. Supplier B's multi-market expected profit will then be profit from sourcing and profit from left over capacity successfully sold on the spot market. With each price-capacity quote on the sourcing market, Supplier B ensures that sourcing and spot market together yield

at least as much as solely the spot market sale. This strategy yields Supplier B a reserve price-capacity curve. Specific characteristics of the curve allow several strategic insights for Supplier B, which we discuss next.[8] There are two immediate implications of the price-capacity curve.

Commitment cost: Supplier B's price-capacity quote increases with capacity committed to sourcing. As Supplier B has less capacity to sell in spot markets, it is less likely to discount its list price. There is a cost of capacity commitment.

Lower margins: A uniform uncertain demand for capacity in the spot market yields a corresponding linear reserve price-capacity curve. The lower margin needed in sourcing relative to that from list price P is due to savings in selling costs, and smaller excess capacity to book in the spot market.

***Strategy Query #15** – How is sourcing price affected by expected capacity utilization in the spot market?*

Increased utilization: Uncertain demand for capacity in the spot market can fall to as low as none. Supplier B's capacity utilization undoubtedly increases when it commits a portion of capacity in the sourcing market. However, it should realistically expect that its capacity utilization would be less than a hundred percent. Supplier B's expected multi-market capacity utilization increases as it commits more capacity to sourcing. It is also among other things proportional to its overall capacity, and Buyer B's sourcing demand.

In the absence of any commitment to the sourcing market Supplier B's expected capacity utilization is lowest; it can only increase above this floor level from committing to the sourcing market and selling left over capacity in the spot market. The rising price-capacity curve shows that as capacity utilization increases, price rises (Greer and Liao 1986).[9] For the equal single unit contract award, it is clear that a larger supplier will have a lower reserve price-capacity quote, as CU is smaller for the same sourcing market capacity.

As spot market demand for supplier capacity increases, the reserve price-capacity curve rises. Put differently, as spot market risk falls, the reward sought by a supplier in the sourcing market rises. As sourcing market risk reduces when the buyer's required capacity (Λ , in Exhibit 14.1) increases, Supplier B faces the same effects.

Smoothing capacity utilization

Celestica for example is involved with dozens of exchanges for spot purchasing, as well as contract manufacturing. Companies are creatively using online auctions to smoothen excess and shortages. Global spot shortages are solved through online exchanges.

Avnet Inc., a Phoenix USA company, is in the process of globalizing its material management. The growth rate of customers who execute global sourcing is 45 %.

Source: McKeefrey, Hailey L. (2000). Global procurement. Electronic. July 31, p. 58.

14.5 Numbers of suppliers

The dependence on number of suppliers in capacity constrained parallel sourcing can now be made clear. There is a tradeoff between gains from splitting capacity required and increase in the numbers selected. The first capacity effect is to reduce price dictated by the price-capacity curve, while the second selection risk effect increases price. With the resulting tradeoff, Buyer B can determine its optimal number of suppliers. Let us examine the tradeoff more closely.

The optimum number of suppliers is dependent on three parameters: buyer's required capacity; number of bidders; and the supply base capacity distribution. This multi-supplier number that minimizes acquisition cost is directly proportional to total capacity requirement, and the number of bidders; and inversely proportional to capacity range in the supply base among rival bidders to Supplier B. The optimal number is independent of supplier specific information such as unit production or search costs. Therefore, the buyer could declare and commit to the optimal number of suppliers in sourcing in advance of learning these things.

A greater number of suppliers decrease required capacity from each. This (a) reduces capacity booked from a supplier, with a resulting lower operating portion of the price-capacity curve; and (b) increases sourcing market selection risk by reducing capacity reservation variance among bidders, with a resulting increase in aggressiveness of bidding. Both these effects lower bids.

Yet, a greater number of suppliers reduces risk of selection, and induces higher bids on that account. Moreover, vendors with increasingly higher price-capacity curves will need to be brought on board the program, and this will certainly increase price.

The net trade-off will yield an intermediate optimal number of suppliers. In the event that the number of bidders does not significantly exceed the intended number of suppliers, Buyer B should divide required capacity into multiple procurements. This would lower required capacity per round, Λ, and consequently the intended number of suppliers for a given round.

14.6 Two price-quantity award types

While Buyer B has common knowledge of average unit production cost, and spot market demand uncertainties, it might not have knowledge of a particular supplier's available capacity for the sourcing period. It is reasonable to assess a distribution for supplier available capacity, such as the uniform distribution, which leads to a distribution of reserve price-capacity curves. The buyer must find a mechanism to select the most efficient suppliers. In the rest of this chapter, we examine two types of award mechanism Buyer B might use. One, the *fixed quantity-market clearing price* award, requires an *equal* single award to each of selected suppliers. The second, the *fixed price-market clearing quantity* award,

requires *variable* quantity allocations based on a uniform award price determined from price-capacity curves. We can variously refer to these as fixed quantity awards; and variable quantity awards. We will see below that both are VCG mechanisms.

14.7 Fixed quantity-market clearing second price award

Strategy Query #16 – *What is the "lots" option for capacity constrained suppliers?*

Buyer B decides to employ a price discovery mechanism with the uniform second price reverse auction, and splits the contract into "lots."[10] This practice of splitting the contract into equal lots for single lot awards, and informing vendors on the number of lots *a priori* in sourcing and even electronic markets is commonplace (Jap 2003).

The incentive compatible bidding mechanism for the equal single unit award is equivalent to the Vickrey multiple source reverse auction. It is the *lowest rejected price bid* multiple source auction, where the bidder finds it optimal to reveal to the buyer its reserve price knowing that the award will be made at the lowest rejected bid (see Chapter 7 for a fuller discussion). What is Buyer B's expected award price for the capacity it needs? The answer is straightforward. The expected award price is the list price, less the composite discount. The discount comprises the $k+1$th supplier's expected margin as discussed in §14.4 above.

14.8 Fixed price - market clearing second quantity award

Strategy Query #17 – *What is the "second quantity" award for capacity constrained suppliers?*

In the parlance of auction mechanisms, we will dub this the variable quantity the *"second quantity"* award, for reasons that will become apparent. The award proceeds as before, except all selected suppliers do not get an equal allocation of Buyer B's required capacity. Instead Buyer B fixes price and takes differing capacities that correspond to this price from selected supplier' reserve price-capacity curves. Buyer B's choice of price should enable its total capacity reserved across suppliers to satisfy its own total requirement.

Buyer B's problem here is to induce truthful vendor revelation of its reserve price-capacity curve, i.e., be incentive compatible. This is a variety of VCG mechanism as described in §9.4, as it compensates the supplier on the externality it exerts. To introduce the concept of the *second quantity*, or the lowest removed quantity, award let's say Buyer B prices the award for "one-less-than-required" suppliers at the uniform price that yields capacities which add up to its requirement, Λ. Clearly, this price will be *higher* than a similar approach for the

required number of suppliers, which adds a supplier to the previous case.[11] The increase in price is necessary when the capacity of the least efficient of selected suppliers is removed. With this award each supplier gets a price for a higher capacity, although it supplies a lower capacity.

The *second quantity award* is defined as the award where the k best selected suppliers together provide the buyer's total required capacity equal to their aggregated capacities. The capacity due from each is determined by a uniform fixed price (not the award price) corresponding to their reserve price – capacity curves. A higher uniform price would clearly be needed, when the single most expensive selected supplier is rejected, for due capacities from *(k-1)* suppliers to match the buyer's total requirement; the k suppliers receive this higher uniform price.[12]

The intuition behind incentive compatibility of the second quantity award is straightforward. Vendors now have an incentive to report reserve levels of their price-capacity curve as the bid. This way they maximize their chances of selection without reducing the award price, given all rivals use this strategy. A further reduction will reduce the vendor's expected profit since there is now a chance that a higher than reserve capacity must be provided on selection. Truthful revelation is a dominant strategy.

14.9 Price-Quantity awards as efficient and optimal mechanisms (Advanced topic)

***Strategy Query #18** – What is the optimal award for a capacity constrained supplier?*

In the presence of a price-capacity curve, why are these second price and second quantity reverse auction types attractive? One answer comes from principles of efficient mechanism design for which a Vickrey-Clarke-Groves (VCG) mechanism is optimal, as discussed in §9.4. Both second price and second quantity awards as described here are VCG mechanisms. This is intuitively clear if we remember that the principle of the VCG mechanism the efficient supplier is selected and gets paid the extent of its externality. For instance, in the second quantity award all suppliers have better welfare at the uniform price matching capacity when there is one less supplier since each has a higher capacity to supply. Inclusion of a supplier at the same uniform price lowers everyone's utility, as now they have a lower capacity to supply.

There is a supplier externality that can determine its payment. Selected suppliers get paid the higher uniform price set by the situation where there is one less supplier for the buyer's total required capacity. This is essentially the payment rule for a VCG mechanism. Since the most efficient suppliers are selected in the direct reverse auction with symmetric bidders, the second price and second quantity awards also obey the generalized VCG allocation rule. Therefore, these are attractive awards as they deliver supplier welfare above

opportunity cost to suppliers who value contract allocations the most. The argument with reference to Exhibit 14.1 helps fix the ideas. Contrast the following cases.

Fixed quantity first price single source: L1 gets the whole capacity at its bid price, higher than its reserve cost P(k=1). Its compensation is the area under its supply curve corresponding to its bid price times Λ. Clearly it should raise its bid price until L2's expected bid price for Λ, and truth telling is not an equilibrium strategy. This is not an incentive compatible auction. L1's expected surplus is maximum at this bid margin times Λ.

Fixed quantity market clearing price dual source: This is the standard Vickrey dual source reverse auction, or second price reverse auction. Without say L2, the two selected bidders will be L1 and L3. Focus on L3, the last added supplier when L2 is absent. Allocation of Λ/2 at **P3** to L3 adds a welfare to others in the supply base equal to the corresponding area under L3's supply curve; this welfare will be lost to all others when L2 is present and selected. L2's externality is the net loss of welfare to others in the supply base; therefore the VCG auction doesn't count L2's welfare from selection for estimating the externality it exerts. The buyer should pay exactly this externality to L2 as the necessary and sufficient condition for an efficient allocation to be a VCG mechanism. Then truth-telling is a dominant strategy and incentive compatibility prevails. The buyer satisfies the condition as it pays **P3** for Λ/2 from L2, exactly the amount lost from displacing L3.

Fixed price market clearing quantity: Is this a VCG auction? Here is a simple consistency check. Lets say it was. Then all suppliers bid truthfully. For this to happen L2 should be paid exactly its externality in changing the award from single source without it to dual source with its inclusion. Does this condition hold? In the single source L1 would truthfully bid P(k=1) for Λ, and the award provides a welfare to the supply base of the area shown under L1's curve. With L2 (dual sourced) and the same price P(k=1) the welfare of all others is $\lambda 1$ times P(k=1). The externality exerted by L2 is the area under P(k=1) between $\lambda 1$ and Λ. But this is exactly the area under P(k=1) up to $\lambda 1+\lambda 2$. Recall that Λ is the sum of $\lambda 1$ and $\lambda 2$. The condition holds. Notice that the allocation is efficient as the allocation of $\lambda 1$ and $\lambda 2$ at P(k=2) gives the supply base its maximum surplus. The buyer pays L2 exactly its externality by setting the price at the single sourced award for the dual sourced market clearing quantity. Therefore truth telling is the dominant equilibrium and our consistency check is positive for this second quantity reverse auction.

These efficiency and incentive compatibility qualifications make all VCG mechanisms attractive. Which of these two price-quantity award types should the buyer prefer? The buyer would prefer the second price to the second quantity award based on lower acquisition costs for the former. The optimal generalized VCG mechanism is that which is based on the type that minimizes social welfare net of the supplier's opportunity cost (as elaborated in §9.4.3). Splitting the same

contract into equal fixed quantities results in a smaller net welfare than variable quantities. This is because elasticity of supply price with capacity utilization is less than unity. Therefore, the fixed quantity VCG award is less expensive for the buyer than the variable quantity award.

When quantity is equal and fixed, the only type characteristic necessary to differentiate supplier bids is opportunity cost at that quantity. However, when quantity is variable, the buyer needs suppliers to report capacity as their type characteristic, as the buyer need to know the price-capacity curve to differentiate bids at various quantities, rather than just the one price at a given quantity. Here is an illustration of two competing type characteristics for competing VCG mechanisms. Opportunity cost is clearly the best type characteristic as it leads to lower buyer payments. This further illustrates principles elaborated in §9.4.

14.10 Comparisons

The numbers of suppliers are not fixed and the number of suppliers may be further optimized. For either award type, the buyer can choose the number of suppliers to select. There is a difference in the optimal number of suppliers for the two award types, as there is the usual tradeoff in multi-sourcing between capacity utilization and efficiency of the last selected supplier. Interestingly, this difference diverges with the range of supplier capacity. Interestingly, the optimal number of suppliers is lower for the fixed quantity award.

The increase in range of capacity in the supply base raises the award price for variable quantity and drops that for fixed quantity second price awards. Clearly, when buyers can expand their supplier base to include widely varying capacity suppliers they would obtain lower opportunity costs and consequently lower acquisition costs from the fixed quantity award. This is a motivation to include high capacity global suppliers in sourcing.

When would a buyer ever prefer the variable quantity award? The lower acquisition costs of the fixed quantity VCG based on opportunity cost is unlikely to let this happen. One reason for such preference might be when supply price elasticity with capacity utilization rises above unity. Another reason might be the extraneous consideration of capacity development in the long term. The buyer might want to include some incentive for capacity increases, and the variable quantity award that rewards higher capacity suppliers with a higher quantity rather than a fixed quantity for all gives this flexibility. The buyer can estimate the tradeoff in acquisition price increase from a capacity management objective by comparing the variable quantity award with the fixed quantity award.

14.11 Opportunity costs with joint costs.

Opportunity cost to define seller types in reverse auctions is a key consideration for individual rationality constraints, where suppliers may not participate if profits do not exceed their opportunity costs. Even after the entry decision, opportunity costs influence profits suppliers desire from sourcing business. The price-capacity curve unbundles the seller's opportunity cost. It provides the rationale for bidding strategies based on the spot market, and reveals the opportunity cost relationship with supplier capacity and selling costs.

Strategy Query #18 – *Why does divergence of joint cost from opportunity cost lead to buyer problems when fixed price contracts are not used?*

Supplier B is often faced with the necessity of allocating joint costs over parallel markets. This comes from producing for the sourcing contract as well as the spot market. A supplier's allocation of joint cost to sourcing could simply be in proportion to fraction of business output represented by sourcing. There is some discretion on units of measure of output (Cohen and Loeb 1990).[13]

Buyer B cannot observe Supplier B's opportunity cost, but certainly gets to learn allocated joint cost; and this leads to a distortion when linear incentive contracts (see §7.4, §16.4, and Chapter 17) are used in lieu of fixed price contracts. The likelihood of the winning bidder having the flexibility to allocate joint costs *ex post* to sourcing makes fixed price contracts more desirable. This view validates Buyer B's fixed price award reverse auction for capacity constrained suppliers, as discussed here.

In the presence of cost sharing and joint cost allocation, a strategic possibility opens for the supplier to raise its input costs as a portion is allocated to sourcing business. The net effect is a much higher input cost than when selling solely to the spot market. The decision on total input costs depends on the level of cost sharing in sourcing, i.e., on the elasticity of input costs with cost sharing. Opportunity cost of sourcing business can then dramatically increase. The effect of joint cost allocation is to introduce a significant divergence between the supplier's opportunity cost in the spot market and observed cost as allocated in the sourcing market. When some likely conditions hold then a fixed price contract strictly dominates the incentive contract (Cohen and Loeb 1990).[14]

Costs can rise dramatically if Buyer B subsidizes cost in sourcing markets. Cross subsidization in the spot market may swamp out any benefit of increased competition that incentive contracts introduce. Fixed price contracts are clearly preferable when risk neutral suppliers can use their capacity in both spot and sourcing markets.[15]

14.12 Conclusions

This chapter shows inter-relations between capacity utilization and opportunity cost through a supplier's price-capacity reserve price. When suppliers

have capacity constraints and sell in parallel markets, the buyer may find it preferable to split purchase among multiple suppliers. The intuition behind this design is that reserve prices fall when lower capacity is required from each supplier. Uncertain demand and consequent selling costs in local spot markets drives the reserve price-capacity curve. This chapter reveals the explicit dependence on demand uncertainty, supplier capacity, alternate market price, and number of suppliers, and illustrates the role of the price-capacity curve in the reverse auction.

The recommendations determine the optimal number of suppliers among whom the buyer should split the purchase, and the buyer's preference for fixed quantity second price awards relative to variable quantity or fixed price second quantity awards. In sum, unbundling the vendor's opportunity cost in such a scenario overcomes a strategic shortcoming in our understanding of sourcing strategy.

14.13 Strategy Query Checklist

The strategic questions we pose and answer are:

- *#9 – Why should buyers consider reprocurements?*
- *#10 – Does the buyer gain by unbundling the supplier's reserve price?*
- *#11 -- Should price determine supplier quantity or vice versa?*
- *#12 – How does spot market uncertainty affect sourcing?*
- *#13 – What are additional uncertainties in sourcing?*
- *#14 – What are the spot market price and capacity impacts on sourcing?*
- *#15 – How does expected capacity utilization in the spot market affect sourcing price.*
- *#16 – What is the "lots" option for capacity constrained suppliers?*
- *#17 – What is the "second quantity" award for capacity constrained suppliers?*
- *#18 – Why does divergence of joint cost from opportunity cost lead to buyer problems when fixed price contracts are not used?*

14.14 Proxsy®: Capacity Constraints and Pricing

This scenario helps you design fixed quantity awards and variable quantity awards, and determine circumstances under which each one might be preferable. An additional analysis show how uncertainty in buyer demand is related to capacity reservation contracts among multiple suppliers. It extends your insights from the previous scenario by relating vendor opportunity cost to capacity constraints. The optimal degree of multi sourcing balances risks and returns from

the opportunity cost-capacity constraint tradeoff. Review help screens for additional details.

Exercise 2: Here is the scenario, as depicted in Exhibit 14.2. You wish to award the contract to three suppliers. However, there are many other choices in your design of the RFP when capacity is a scarce resource. You could do it in one shot or have two or more re-procurements. You could use an equal quantity award where you will book an equal portion of the contract from all selected suppliers, at a uniform price. Or you could choose an unequal portion award, which sets a uniform price but varies the quantity or amount of capacity booked from multiple suppliers, with the lowest bid price supplier getting the higher portions.

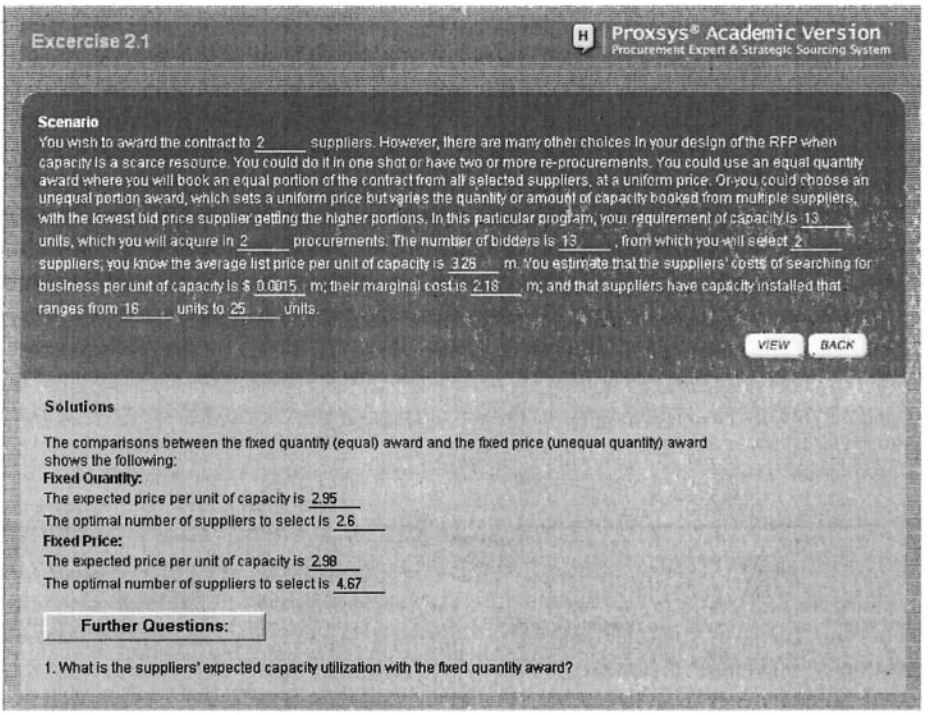


Exhibit 14.2: Exercise 2.1 on Capacity Constrained Contracts. Scenario data is picked up from the environment index as before, but you can make changes. This allows a top level comparison between fixed quantity and fixed price awards. While the fixed price is more expensive, it supports more suppliers.

In this particular sourcing program, your requirement of capacity is 13 units, which you will acquire in two procurements of 6.5 units each. The number of bidders is ten, from which you will select three suppliers; you know average list price per unit of capacity is 0.7 m. You estimate that suppliers' costs of searching for business per unit of capacity is $150; their marginal cost is 80% of their list

price; and that suppliers have capacity installed that ranges from 10 units to 20 units; and that supplier alternatives to sourcing business ranges from 10 m to 23 m.

Further questions: What is suppliers' expected capacity utilization with the fixed quantity award?

Exercise 3: This is a deeper look at the previous scenario. You have further questions and selected the scenario for Fixed Price Award, also known as a variable quantity award. This sets a uniform price but varies the quantity or amount of capacity booked from multiple suppliers, with the more efficient supplier getting higher portions of the overall requirement. You must decide quantities to allocate to each supplier. This particular program is as in exercise 2, and the reports are depicted in Exhibit 14.3.

Further questions: How does allocation change for 4 re-procurements? Does allocation depend on supplier diversity, as captured by range of supplier capacity?

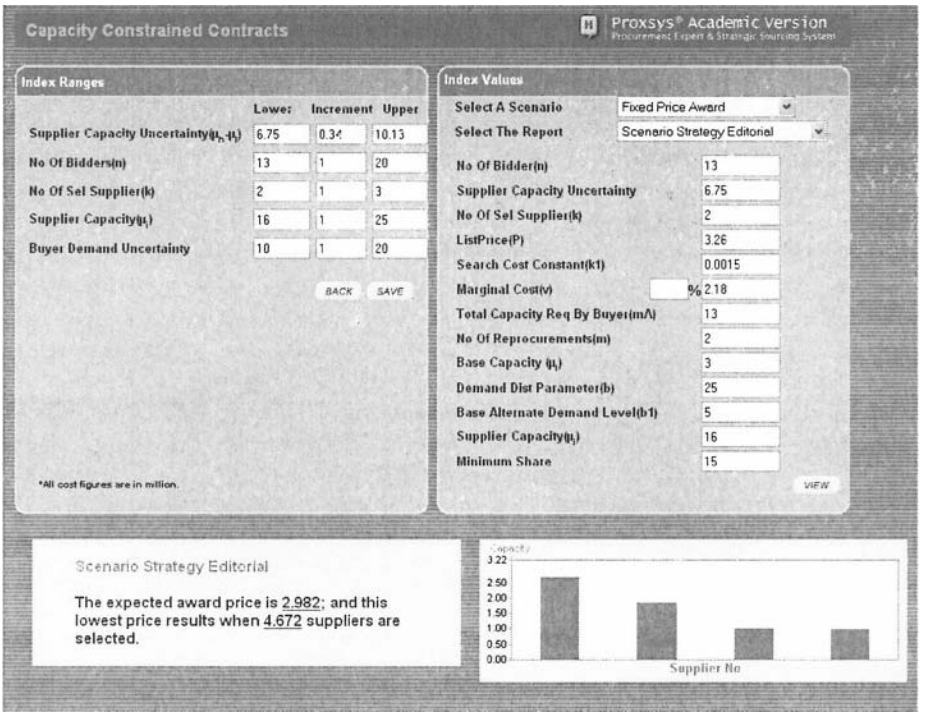


Exhibit 14.3: Fixed Price Award on Capacity Constrained Contracts. Scenario data is picked up from the environment index as before, but you can make changes. For instance, you can readily change the marginal cost as a percentage of unit price. The report shows the variable quantity to allocate per supplier based on their efficiency to satisfy the per procurement quantity required.

Exercise 4: This is a variation on the previous scenario, with the additional complication that you are uncertain about your capacity requirement. Therefore, you should book a pre-determined amount of capacity with suppliers in order to obtain better prices with the intention of procuring the remainder on the spot market. Your choices in design of the RFP center about how much to book, among how many suppliers.

For this particular program, the per-round sourcing capacity you require can range anywhere between 10 and 20 units; the scenario is largely as in Exercise 2, with the restriction that you will use only the fixed (equal) quantity award.

Further questions: What are the changes when your uncertainty rises to say, 20, i.e., capacity you require can be anywhere between 10 and 30 units? What is price per unit of capacity reserved? These reports are depicted in Exhibit 14.4.

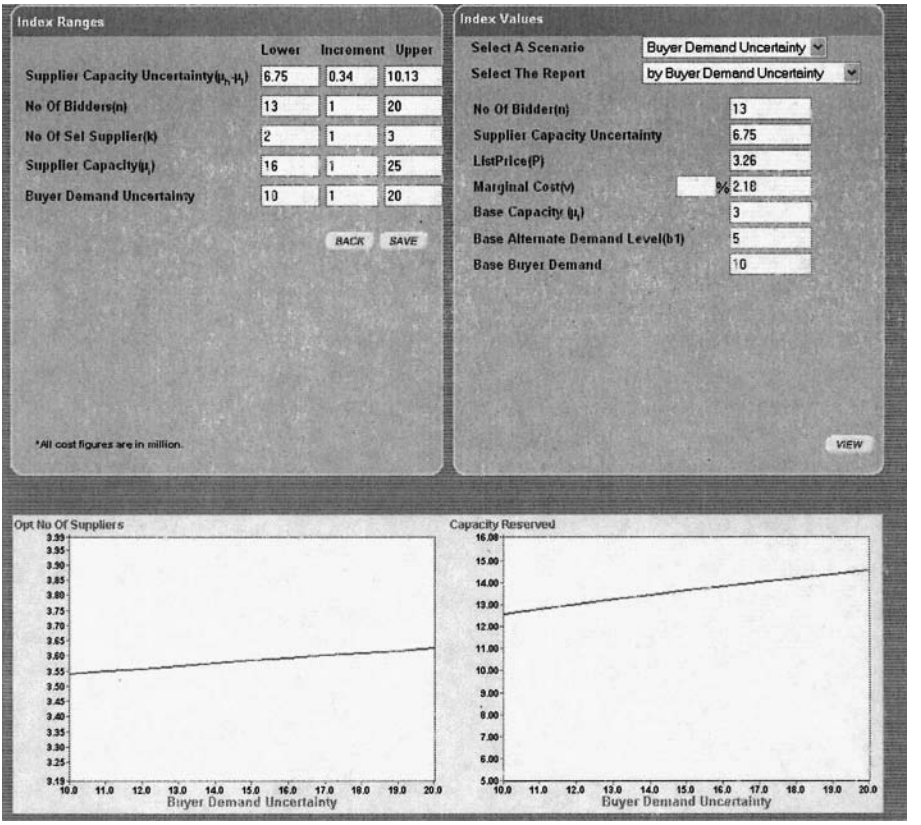


Exhibit 14.4: Buyer Demand Uncertainty on Capacity Constrained Contracts. Scenario data is picked up from the environment index as before. The report shows the fixed quantity award results for demand uncertainty. The optimal number of suppliers and the recommended capacity the buyer should reserve vary with the level of demand uncertainty.

15: Syndicates, Risk and Demand Uncertainty

15.0 Introduction

So far we have discussed sourcing by risk neutral buyers from risk neutral vendors. But vendors in the supply base may not be risk neutral. For instance, consider small resource exploration, energy, or re-insurance companies facing a highly risky demand environment. The magnitude of risk premiums and insurance rents required introduces considerations of horizontal risk sharing between selected vendors as a motive for multi-sourcing. Companies may consider joining together as a syndicate, rather than taking an individual spot market approach to sourcing. In fact, they may be required to do so by an institutional buyer such as a government infrastructure development agency, or a procurement service provider (PSP).

Advice is non-existent on several strategic questions for the syndicate. How big should the syndicate be? What is the best sharing rule when vendor opportunity cost is not known? How is vendor opportunity cost relevant to sharing rules? What is the syndicate payoff required for participation? Received advice stops short of answers, at the simpler scenario of known syndicate participants with complete information on payoffs and observable supplier characteristics. Strategic advice, therefore, has significant barriers to breach before PSPs can effectively use syndicated sourcing.

Let us tackle these barriers with the fixed quantity multi-source award of Chapter 14 as an initial basis for this chapter's extensions. Unlike in Chapter 14, vendors we consider here are risk averse, and rewards from winning the contract are uncertain; but like before, the vendor's opportunity cost is private information. An aggregator of supply, such as a PSP or web exchange, may consider buying from several companies treating them as a syndicate in order to distribute risk among them; or companies may come together voluntarily. Buyer syndicates are common as well, where aggregation of demand for discounts (ADD) is a motive, whether in the private enterprise or public expenditures system. This chapter discusses syndicate sizing, and tradeoffs between spot markets and syndicated vendors for efficient sourcing where horizontal risk sharing in the supply base is an option.

15.1 Web exchanges

Specialized markets for exchange of intermediate goods have emerged in recent years. The internet version of such trading hubs are web exchanges. Web exchanges may be analyzed with normative models of "thin" markets of a few members, with multiple buyers and sellers. There also has been the emergence of procurement service providers, or PSPs, for the firm that wishes to outsource its outsourcing activity. Web exchanges also function as aggregators of supply, and could be particularly beneficial in risky market demand situations. While there may be many registered or permanent members, the buyer's process of vendor selection for a specific program on a web exchange is often based on RFIs, RFQs, qualifying technical criteria, followed by commercial criteria similar to other sourcing processes. Web exchanges offer the potential for formal sourcing processes on a repetitive and frequent use basis.[1]

Existing web exchanges use some forms of reverse-auctions for specific program awards, where the award either is wholly to the best bidder or may be split amongst successful vendors based on sharing rules.[2] Split-awards where all vendors receive variable shares can be differentiated from multiple unit awards where best bids are selected for equal unit awards. The latter variety, also called multiple unit awards, are generally assumed to increase average unit prices since vendors with higher unit costs are also being selected.[3] But this argument is for vendors acting individually, rather than as members of a web exchange with elements of syndication. B2B exchanges offer an easy route to vendor syndication.

15.2 Sourcing from syndicates

Strategy Query #19 – *What are advantages of sourcing from syndicated suppliers?*

Let us ask why vendors should consider syndication. There is a long history of syndication, with instances from bond issues, insurance cooperatives and oil exploration (Pratt 2000).[4]

Syndicates and competencies: We have seen how sourcing from multiple suppliers can overcome capacity constraints of small vendors in Chapter 14, and syndication also offers these advantages. Aggregation of demand for discounts (ADD) is a common feature of web purchasing; and it is logical to ask whether aggregation of supply for efficiencies (ASE) is possible as well. While splitting sourcing among independent suppliers is an effective measure for homogeneous product amenable to splitting, this approach is not available to heterogeneous product, such as a joint contract with differentiated activities. Then syndication would help.

Syndicates and welfare: Suppliers who value the firm's business may not be able to provide the entire requirement as a one-stop service provider. Portions that

they can provide are likely to be of higher quality and lower price due to specialization in their areas of competence. Empirical studies have shown that joint bidding for Offshore Continental Shelf (OCS) petroleum leases, typical of heterogeneous risky value product, has several benefits. Joint bidding reduces risk; allows firms to increase their bidding budgets; and encourages entry of smaller firms.

Syndicating multi-tier contracting: Many larger projects have sub-contracting by prime contractors. Tier I and II suppliers already display some aspect of syndication when they participate in bid preparation. However, syndication differs from subcontracting in that supplier offerings are in a single tier, with the same information structure and simultaneous bids.

Syndication for resource sharing: Return on resources such as capital employed is a key measure for vendor projects. Risk may often not be commensurate with return on the project. However, if horizontal resource sharing is possible the extent of a vendor's commitment is lowered. Especially if resource sharing also reduces risk, the risk-return balance may turn favorable.

Syndicates and risk sharing: A chief advantage of syndication is that horizontal risk-sharing is a strategic possibility, even for heterogeneous product. This tends to raise the number of bids received by the bid taker; and significantly raises the winning bid in a high bid auction (Moody and Kruvant 1988).[5] Analogously, a low bid reverse auction that allows joint bidding by suppliers would exhibit corresponding advantages.

Business risks that can be shared owe their origins to volatile demand, cancelled orders, foreign exchange fluctuations, and the notorious bull whip (amplified inventory volatility) effect in the supply chain that increase risk for upstream vendors. A serious risk in web based sourcing when payment processes are offline is due to violation of commercial terms. Vendors in such situations widely fear delays or eventual default in realization of accounts receivables. These fears are more the rule than the exception in many emerging economies. Estimation errors are a big source of risk, and a serious mistake could lead to losses in bidding situations – what is termed the "winner's curse" effect.

Further issues arise: How does horizontal risk-sharing in the supply base reduce the buyer's expected price? How does this expected syndicate bid price depend upon reverse auction rules? Does it depend upon syndicate sharing rules? And do these auction-sharing rules interact? Can we determine an optimal number of members in the supplier syndicate? If this optimal number is greater than unity, then rather than single-source their requirements, buyers should actively encourage bidder syndicates.

A higher risk aversion is equivalent to a lower risk tolerance. The *constant absolute risk aversion* (CARA) discussed earlier is the only supplier risk attitude that yields a linear, synchronous and efficient (LSE) sharing rule even for differing or heterogeneous beliefs on the distribution of syndicate payoff (ibid.). It also eliminates the need for background risk and wealth considerations that suppliers may engage in during syndication, as CARA suppliers have separable

risk premiums. Buyer C will therefore view Supplier A and other vendors to be CARA in their risk attitudes, as in previous chapters. Symmetric vendors have similar CARA attitudes and beliefs about sourcing.

This chapter explores these questions for integrated bidding with horizontal risk-sharing. The next section reviews some key syndication and risk attitude concepts.

15.3 Multi-sourcing auctions and horizontal risk sharing

Explanations of strategic effects of horizontal risk-sharing on bid prices are scarce, although analysis of horizontal risk sharing in syndicates is not new, and continues to attract attention (Pratt 2000). A starting point is the standard syndicate model, where multiple agents come together to share business risks and devise reward sharing rules.

Here is the typical scenario. Buyer C is a buyer, a web exchange, or a procurement service provider (PSP); and Supplier X (where X can be A, B, C or D to represent many vendors in the supply base that Buyer C can syndicate) is a vendor interested in syndicating. Participation of the required number of Supplier X type companies is not assured, and total budget or revenue for Buyer C's syndicate is not pre-determined. Buyer C's offer for syndicate shares must be robust with respect to vendor private opportunity costs. Therefore, Buyer C wisely uses a reverse auction process that accounts for opportunity costs in the spot market. The integration of offer-and-participation allows Buyer C to balance trade-off between risk-sharing in the syndicate and bid pricing, and optimally sizes the syndicate.

The selection process Buyer C envisages is a reverse auction, or bidding process based on pre-announced reverse auction rules, sharing rules and known syndicate size. The set of vendor bids determine minimum payoff sought by the syndicate from a risky program in a competitive marketplace. In our strategy each supplier gets an equivalent cost portion of the joint program in monetary terms. The unit program yields a syndicate profit upon completion that is divided among participating vendors based on sharing rules also based on the set of bids, rules that have been previously made public. Subsequent sections discuss in turn sharing rules for vendors, vendor bidding competition, the syndicate's competitive bid, and finally optimum syndicate size.

15.4 Sharing Rules

Strategy Query #20 *– What are syndicate sharing rules?*

A sharing rule is an agreed manner by which the syndicate will divide jointly realized profits between its members. The portion each supplier gets is based on relative weights the syndicate assigns to their utilities. In accordance with

principles of syndication, the LSE (linear, synchronizing, efficient) sharing rule requires the following (where any pair of the conditions implies the third) (Pratt 2000):[6]

(i) the optimal sharing rule is linear in the uncertain syndicate payoff;

(ii) the rule is synchronizing in that increases in the payoff will still yield identical optimal sharing formula; and

(iii) optimal sharing is Pareto-efficient in that no participant is worse off while attempting to improve all other participants' payoffs.

15.5 Two Vendor Syndicate

***Strategy Query #21** – How should a two-vendor syndicate share payoffs?*

For the basic insights let us first examine the benchmark case of a vendor pair syndicate, with Supplier A and Supplier B. The syndicate must aggregate supplier utility payoffs as a weighted sum for joint bidding. Weights Buyer C assigns at its discretion to CARA utilities of Supplier A and Supplier B allow it to represent a group CARA utility for the syndicate pair. The tricky portion is how the syndicate should determine supplier weights. We interpret these weights as "the most efficient weights on vendor utility that ensure participation of selected vendors." At this point take weights to be pre-determined; later we show how Buyer C can determine optimal weights from bids.

Buyer C should use a linear, synchronizing, efficient (LSE) sharing rule for the two vendors. The sharing rule gives differing portions of the payoff to each, depending on the weights. Vendors should not get equal portions, as this will not be efficient. The sharing rule tells the syndicate to divide the cake into equal parts and then transfer a slice between vendors, adding it to one while removing this slice from the other. Side payments serve to adjust the agent's utilities upward and downward by a certain proportion that improves joint utility of the syndicate (following Raiffa 1968; Pratt 2000). How should the halves be adjusted to yield efficient and unequal portions? Ideally, the amount sliced off one supplier's share and added to the other's share must just cover the difference in suppliers' opportunity costs. This is the intuition upon which we base our strategy.

The syndicate that aggregates two vendors has a group utility function with half the risk aversion or twice the risk tolerance as any individual vendor. Therefore, when payoff is uncertain, a random variable, Buyer C needs to compensate a smaller total risk premium. Contrast this with two independent suppliers, who will have additive risk premiums that could combine to exceed the single source insurance rent.

With more vendors in the syndicate risk premium reduces proportionately, which is main horizontal risk sharing intuition we will carry forward in our strategy. So far we have assumed that fractions or weights were pre-determined by some unspecified negotiation process; or that the buyer knew the vendor's opportunity cost. The next section specifies a bidding process that achieves the

objective of selecting efficient vendors among many potential members of the syndicate, and allows a determination of weights based on information revelation. This bidding process creates the efficient syndicate.

15.6 Participation in Syndicates

Vendors are rarely already selected and usually have not committed to participate in the syndicate. For instance, vendors may have alternative business opportunities on the spot market or from non-syndicate business, which may in fact be less risky. Utility from syndicate business opportunities must therefore exceed some reserve level. Several components of supplier opportunity cost are uncertain margin, direct and indirect expense on manufacture and delivery, alternative spot market business revenues, search costs, and risk premium. We have explored the impact of some of these components in the last chapter; albeit in the absence of syndication and risk aversion. It is hardly likely that the buyer knows all these for a vendor. Let us therefore build a more robust strategy for private information on opportunity costs in the supply base.

***Strategy Query #22** – When will a vendor participate in a syndicate?*

Vendors will participate in the syndicate over some given period if their expected utility from the syndicate's reward sharing is no less than their spot utility for that period. This is the usual entry condition we encountered earlier, but this time in utility terms due to the risk aversion effect. Then Supplier A's bid for syndicate business in utility terms relates its spot utility to its expected utility from syndicate business.

In our strategy, the vendor syndicate invites bids for a discriminatory second price award. A discriminatory second price reverse auction is not incentive compatible and bids are not truthful revelations of reserve prices, but are padded for information rents. A bid is a desired monetary fee, but can readily be mapped into CARA utility.[7] The supplier if selected will obtain a profit of this fee less any previously announced fixed syndicate expenses. This net profit must be no less than its spot market opportunity cost or reserve price. Buyer C selects the set of vendors with lowest bids to participate in the syndicate.

Spot market: For the benchmark case of two vendors, opportunity costs for Supplier A (the lowest) and Supplier B (the second lowest) vendors are approximately known from their bids

***Strategy Query #23** – Can a reverse auction help determine the sharing rule?*

Efficient vendor participation occurs when Buyer C chooses utility weights in the ratio of vendor spot market opportunity utilities (or "spot utilities"). This allows the syndicate to select qualified vendors with the two lowest spot utilities to minimize the size of cake required; and to transfer side-payment slices based on the ratio of their spot utilities.[8]

Vendors such as Supplier A with capacity constraints are exposed to opportunities on the spot market. Profit opportunity from any single spot market

contract may be uncertain, but Supplier A can estimate mean spot market profits per spot contract. Each additional spot contract decreases the vendor's available capacity a notch, and bumps spot utility up a notch [9] We earlier saw how higher capacity utilization increases prices in a similar fashion.

The vendor has a required minimum return on capital employed. Equivalently, there is a minimum or base spot utility even when all vendor capacity is available.[10] Minimum payoff must still ensure that the least attractive selected supplier gets more than its spot utility.

15.7 The general multi vendor syndicate

The benchmark case for two vendors is conceptually simple, and the intuition may readily be extended to more than two vendors in general. What can we generalize from the vendor pair syndicate? In sum, participation of multiple vendors is ensured when each participating vendor obtains at least its estimated spot utility. For known spot utilities Buyer C is now well informed, and can be sufficiently confident of satisfying participation criteria of Supplier A and its breed; however, vendors enjoy private information about their spot utilities, and will not necessary reveal their private information to other vendors, or in general to the syndicate. This lack of knowledge on spot utilities creates a "second best" sourcing scenario for Buyer C. How should total syndicate payoff be determined? What side payment transfers should occur in the syndicate? There is a different selection problem for Buyer C regarding information asymmetry on vendor spot utilities that necessitates the bidding competition. All these problems also carry over to the multi-vendor case.

To continue what we can generalize from the syndicate pair scenario, for the syndicate to implement the LSE sharing rule and ensure participation as required, suitable incentives must be available for vendors to truthfully or closely reveal their opportunity costs. To accomplish this, Buyer C will have to live with some inefficiency (sacrifice some information rents to vendors). We specify a discriminatory second price reverse auction process to solve this problem, select the required number of vendors, and establish the syndicate's total utility payoffs and each vendor's portion. This solution also carries over to the multi-vendor case.

15.8 Syndicated Bids

In the simplest case, vendors are similar and symmetric, and differ only in terms of their estimated spot utility, which is private information for each vendor. In our strategy, Buyer C offers a bidding competition for vendor selection and compensation, where lowest bidders will be selected and the profit share each gets is based on their bids. Bid takers use a variety of rules leading to a variety of

equilibrium bidding strategies by bidders. Here Buyer C is aware that the discriminatory reverse auction should be used to elicit differing spot utilities. It is known that bid takers prefer discriminatory auctions anyway when bidders are risk averse (Ansubel and Cramton 1996).

The second price discriminatory auction rule applies when Buyer C, the bid taker, selects the lowest bidders, and awards unit portions to each at the next lowest bid price. Thus, the lowest bidder Supplier A gets a unit contract at the price bid by the second lowest Supplier B, and so on.

Discriminatory second price or the "totem pole" award: As in Chapter 14, we examine the multi source reverse auction; but here we examine the *discriminatory price* award. This is a necessity since each supplier has to receive a *different* share of profits by the LSE sharing rule that uses award prices for deciding weights. In a sense, vendors are bidding their utility weights. Uniform pricing will not be efficient for the syndicate.

Discriminatory auctions resulting in a "totem pole" of award prices is an interesting and plausible price discovery process. Since we have examined price-capacity effects in detail in Chapter 14, we will simplify our strategy here to abstract away scale effects. Splitting capacity requirement from the supplier corresponds simply to proportionately splitting the supplier's spot utility. Unlike Chapter 14, Buyer C is dealing with risk averse bidders, and we will think of the auction in utility space. [11]

The *totem pole* award is analogous to a concealed-exit reverse auction. The price is programmed to fall continuously, and the vendor exits privately when its profit falls below some acceptable level.[12] Other sellers are not aware, but the buyer is aware of the level set by each exiting vendor. No seller is aware of how many sellers still remain in the competition, so price falls all the way until the last seller privately exits. The buyer then uses the discriminatory second price levels of private exit prices to award unit contracts to the required number of lowest bidders.

For two or more member syndicates, the totem pole award is not incentive compatible. It does not yield the spot or reserve utility as a truthfully revealed equilibrium bid. The bidder adopts a strategy that pads its bids above its spot utility. See Exhibit 15.1 for an illustration of the totem pole reverse auction. We have computed bids in the exhibit via the incomplete beta distribution that results when we apply principles of equilibrium bidding as mentioned earlier in §12.5 for award (4).

Recall that the LSE sharing rule requires Buyer C to know the spot utility; therefore, the bidding rules result in a departure from the LSE sharing rule. This departure introduces some inefficiency, originating in strategic use of private information on spot utilities by Supplier A and its rivals. The advantage over the multi source Vickrey uniform price auction that would induce truthful revelation is that discriminatory auctions allow higher opportunity cost vendors to be compensated with a LSE sharing rule that *is* discriminatory. This allows vendors to receive varying shares of syndicate profits.

Buyer C can provide compensation to vendors in *approximate* ratios of their spot utilities, rather than exactly and this is still an improvement over equal allocations. In the analogy of the cake, it is better for Buyer C to transfer approximate-and-varying slices as required by each vendor from equal portions initially cut, than to give everyone a standard slice to ensure the highest bid selected vendor gets enough.

Buyer C's strategy so far has prescribed syndicate sharing rules, related shares to spot utilities for participation, and bids to spot utilities for the requisite information. It now is set to determine expected program payoff and optimal number of vendors for the efficient syndicate.

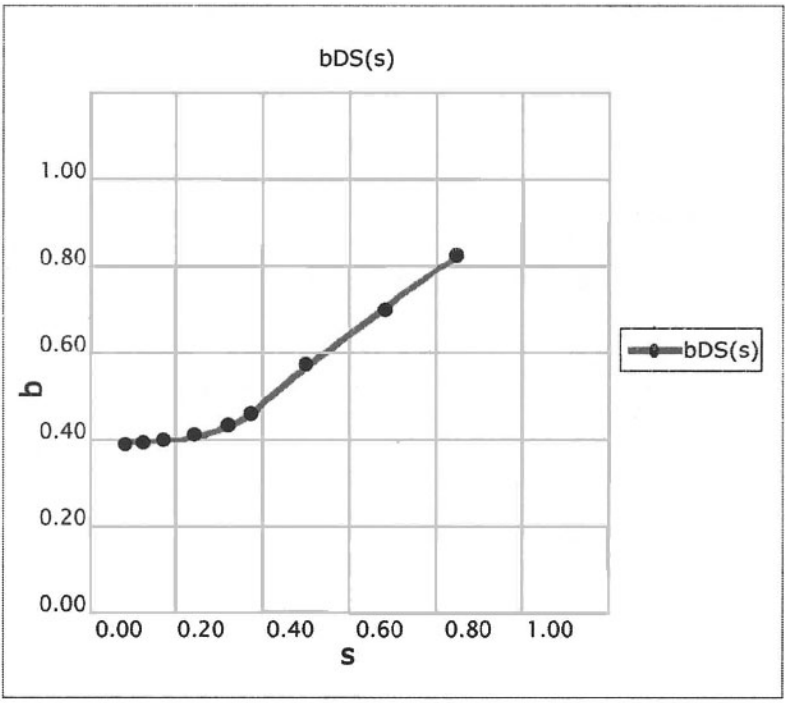


Exhibit 15.1: Discriminatory second price (totem pole) award. In the example, costs, s, range uniformly between 0 and 1.0; the number of bidders is 9; and number of selected suppliers set at 3. The ratio of (j+1)th to the jth cost in the example is 1.30. The discriminatory second price bid is bDS(s), and is plotted as b on the vertical axis for the corresponding cost, s.

A discriminatory second price award sets award price for a selected vendor at its next lowest bid price. This leads to an equilibrium bidding strategy that relates the vendor's bid to its cost, as shown. The plot shows how each cost corresponds to a bid amount. The calculation is from the incomplete beta distribution, in the URL http://home.clara.net/sisa/gamma.htm.

The ratio of corresponding equilibrium bids varies although the ratio of costs is 1.3, indicating a non-linear bidding strategy. The average ratio of bids is less than the ratio of costs at 1.11, with a standard deviation of 0.07. Therefore, a linear approximation is close.

15.9 Efficient syndicate size

***Strategy Query #24** – How many vendors should comprise the syndicate?*

The strategy must tell Buyer C seeks to find the optimal number of vendors to syndicate. Too many suppliers means that gains from risk sharing do not balance price escalation from decreased selection risk and inclusion of less efficient suppliers. Optimality follows from the trade-off between risk-sharing advantages from more vendors and higher program fees or revenues consumed by additional vendors. Buyer C optimizes by seeking suppliers to syndicate, until more suppliers start to increase the syndicate's bid.

More than this optimal number will lead to higher participation prices than is efficient; lower than this number will lead to less efficient risk-sharing. It is interesting to note that optimal syndicate size is not equal to unity in general. Therefore, an auction selecting Supplier A, the independent single risk averse vendor with lowest opportunity cost, *can be improved upon* with the multiple unit award auction, provided vendors Supplier A, Supplier B, and so on, can be syndicated. When optimal syndicate size exceeds unity, the bid taker will succeed in lowering bid price by inviting syndicated bids from aggregated supply. Risk sharing among vendors more than compensates for the additional price required to get higher spot utility vendors on board. In other words, above this threshold the risk-sharing / price tradeoff is in favor of syndicated bids.

15.10 Conclusions

The chapter examined the strategy of supplier syndication for horizontal risk sharing in the supply base. To summarize the main answers, auction rules adopted by the vendor syndicate interact with its sharing rules; these interactions affect suppliers' participation decisions and bid prices. Combined bid-syndicate rules determine reserve syndicate bid price, or minimum payoff required by the vendor syndicate to ensure participation of the required number of vendors. Specific auction and sharing rules influence optimal syndicate size.

There are several strategic recommendations here. What high risk scenarios are suitable for sourcing syndicates? The advantages are most when vendors need to compete for scarce business in a buyer's market. Risky purchase situations drive up their costs, and misestimates of profits could very easily result. Joint bidding with other suppliers allow risk sharing along with sharing of direct program costs. What influences optimal syndicate size? There are several influences: the syndicate grows larger with lower risk tolerance, higher payoff uncertainty, and lower opportunity costs for vendors. When do low barriers to aggregation exist for syndicates? Implementation of joint supplier aggregations over web syndicates is an easy and potentially attractive function. Web syndicates as B2B supply aggregators already compete for business in various sectors of industry, and PSPs use this configuration in their business plans. Why should

vendors consider syndication? With appropriate sharing rules when business is won by the syndicate, and appropriate auction rules for most efficient vendor selection and participation, the syndicate may minimize costs and maximize the likelihood of winning business. What size of pie allows suppliers the slice they need for participation? The concept of *reserve syndicated bid* payoff emerges from the approach of combining vendor bids with sharing rules. This is the lowest bid program payoff that ensures vendor participation in a syndicate of given size, and represents the initial slice of the cake for each vendor, from which portions are shaved off or added for side payments among vendors. When sharing rules are applied to this bid it must provide sufficient compensation to vendors for participation. The lower this reserve syndicated bid gets the more likely it is the vendor syndicate will win business. The vendor syndicate can minimize the reserve syndicated bid by employing a more efficient bid-selection mechanism, and using bidding information to approximate optimal sharing rules, which are linear, synchronizing and efficient. Why should award price be discriminatory? There are particular advantages from discriminatory rather than non-discriminatory bid pricing auctions. In the former, each vendor is differentially rewarded based on his bids. Sharing rules use information in the discriminatory second price auction to allocate shares to selected vendors; guarantee rewards that exceed their opportunity costs; and ensure participation if selected. Linear, synchronizing, and efficient rules result in vendor syndicates that are more likely to be frequented by OEM buyers, since they price lower.

These results allow web exchange administration services that make business sense. Possible services include syndicate sizing, administration of share allocation rules and reverse auction rules. Formal procedures that ensure transparency are important for perceived fairness in share allocation and reverse auctions. Historical bid information allows calibration of opportunity costs, risk aversion and uncertainty in OEM business. Bid data logged by such exchanges over time allow such data mining information.

15.11 Strategy Query Checklist

The queries posed and answered by this chapter are:

- *#19 – What are advantages of sourcing from syndicated suppliers?*
- *#20 – What are syndicate sharing rules?*
- *#21 – How should a two-vendor syndicate share the payoffs?*
- *#22 – When will a vendor participate in a syndicate?*
- *#23 – Can a reverse auction help determine the sharing rule?*
- *#24 – How many vendors should comprise the syndicate?*

15.12 Proxsys®: Syndicates, Risk and Demand Uncertainty

This scenario helps you design a syndicate for vendors. It extends your insights form Scenario 1 by relating uncertain profits, opportunity cost ,and risk premiums to multi sourcing. Optimal syndicate size balances risks and returns. See Exhibit 15.2 for an example screen.

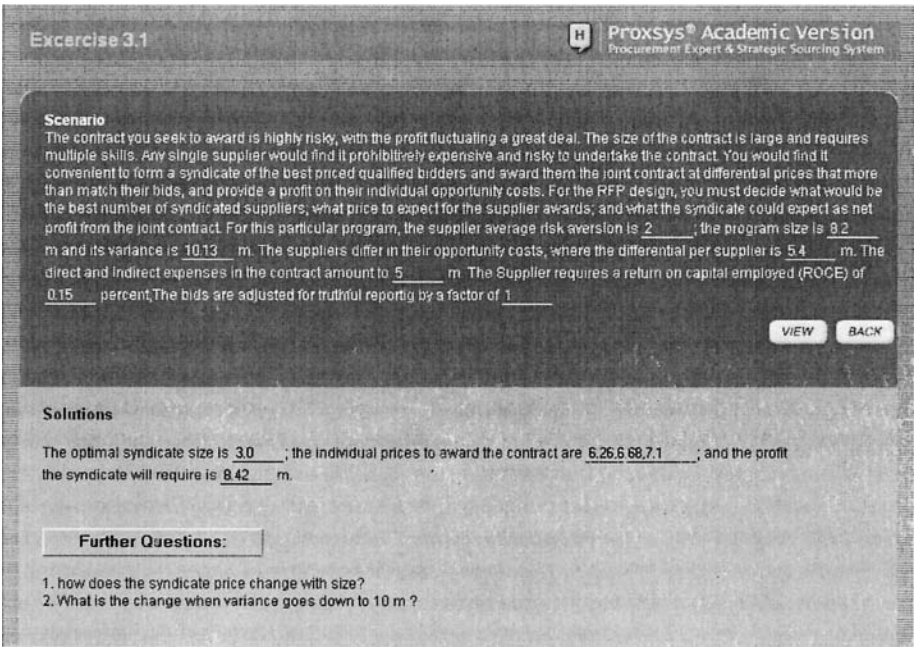


Exhibit 15.2: Exercise 3.1 on Syndicated Source Contracts. Data is picked up from the Sourcing Indexes but you can make changes in the scenario. You then view the basic solutions.

Exercise 5: The contract you seek to award is highly risky, with profit fluctuating a great deal. The size of the contract is large and requires multiple skills. Any single supplier would find it prohibitively expensive and risky to undertake the contract. You would find it convenient to form a syndicate of the best priced qualified bidders and award them the joint contract at differential prices that more than match their bids, and provide a profit on their individual opportunity costs. For the RFP design, you must decide what would be the best number of syndicated suppliers; what price to expect for supplier awards; and what the syndicate could expect as net profit from the joint contract.

For this particular program, supplier average risk aversion is 2; program size is 20 m and its variance is 10 m. Suppliers differ in their opportunity costs, where the differential alternate profit per supplier is 0.7 m. The direct and indirect expenses incurred by any supplier in entering the syndicate is 5m.

Further questions: How does syndicate price change with size? What is the change when variance goes down to 5m ?

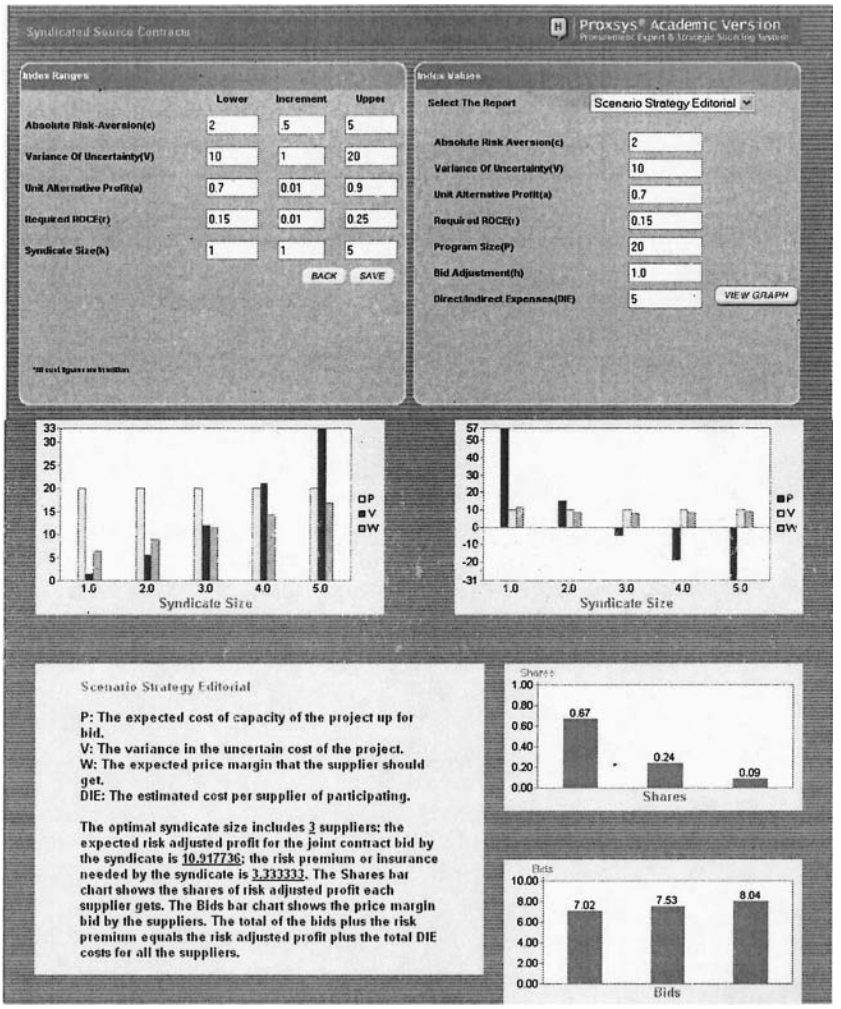


Exhibit 15.3: Syndicate source contracts. The strategy editorial is supplemented with bar charts that correspond to optimal shares and bids for the optimal syndicate.

16: Risks and Resource Sharing

16.0 Introduction

Buyers such as larger firms or government agencies have well hedged supply portfolios and are relatively less risk averse, and therefore risk neutral attitudes may be a reasonable working assumption. But vendors as small firms usually have severe resource and capacity constraints, are highly dependent on a single buyer, and are therefore often very risk averse. This vertical differentiation of risk attitude has potentially profound implications for sourcing. What sourcing strategies are especially due to vertical differences in risk aversion? The next three chapters deal with these considerations in sourcing from risk averse vendors. In this chapter we begin with the impact of risk aversion on capacity or resource non-availability. We focus on resource sharing in a sourcing arrangement for Buyer D, a risk neutral buyer who procures from smaller, risk averse vendors, such as Supplier D.

Naïve sourcing strategies with resource sharing agreements ignore the supplier's incentive to both avoid risks and to misrepresent costs if possible, and miscalculations and uncertainties impose additional financial burdens. Loan agreements shift the balance achieved by risk allocations from incentive contracts. The supplier is forced to incur the financial burden of debt in an uncertain cost environment, and would require added insurance against this risk. Lump sum investments when made by the buyer may end up being non recoverable once the project is done, and represents a sunk cost. The popular progress payments scheme suffers from the need to audit progress several times before the supplier completes the project, and suffers from frontloading of fixed costs by suppliers to get larger payments earlier. Simple equity and profit sharing approaches ignore the supplier's incentive to claim higher efficiencies and lower costs. A more mature strategic view is required, cognizant of risk management as well as influence of information asymmetry on resource sharing.

Volatility of Supplier D's business environments leads to its recognition of the importance of business risk management. How can risk be better managed? Principles of risk management tell us that Supplier D and vendors like it can reduce business risk by the simple expedient of transforming fixed costs and investments into variable costs for spot market business, or into project specific costs for sourcing markets. They should employ better contracts that apportion the financial burden of risk. Buyer-supplier contracts in any case reflect risk sharing in an environment of transaction specific investments and dedicated

resources. For better risk management vendors should allocate these costs in to their contracts, in full or in part. This chapter focuses on how sourcing contracts interact with vertical resource sharing and risk sharing in incomplete information situations.

16.1 Supply relationships and resources

Risk and resource sharing occurs at various stages in the supply chain. Supply chains extend from raw materials to finished consumer products; and firms in the chain differ in terms of resources they command. What will convince firms to share resources in the supply chain? Ideally, each firm in the fully coordinated, first best "virtual corporation" supply chain should act as though it owns an equity share of the overall corporation, and pool resources. Then their returns should be governed by the amount of resource participation. This is the "first best" strategy of resource sharing in the supply chain.

While complete-information on resource allocation in the supply chain is a goal, the virtual corporation it requires is far from reality. Differing utilities and risk attitudes of members, asymmetric information, and private costs in the supply chain lead to departures from the first best strategy. Rewards to individual members must reflect risks involved, and matching risks and rewards from one entity to the next in the supply chain does not happen without careful designs.

Relationships and trust are critical to resource sharing in the supply chain (Morgan and Hunt 1994). Longer term procurements under incomplete contract environments reveal limitations of contractual forms in dealing with contingencies. The irreplaceable role of relationship marketing in sourcing is more fully discussed in §2.2. Buyers and vendors are also aware of the importance of appropriately designed contracts when possible in strengthening relationships and trust. Contractual approaches to resource sharing are of particular interest from this perspective.

Strategy Query #25 – *When do buyers avoid long-term financial relationships with suppliers?*

Government sourcing of public goods perforce must eschew longer term relationships with specific vendors. Many official guidelines hold directives on arms length relationships, and go so far as to specify specific terms for debt financing if financial resources are disbursed prior to completion of the contract. Perception of fairness with public money is critical. How may the buyer maintain the perception of fairness across diverse interest groups such as the taxpaying public, the small resource constrained risk averse vendor, and the large bankable corporation? Buyers in the public interest, and often even private interests, must design specific contractual forms that allow no financial favors, involve no carryover commitment beyond the specific sourcing, and are equally accessible by all vendors regardless of their risk attitudes and resource constraints. Such

contracts must apportion risk equitably as well as achieve a desirable level of resource sharing within the supply relationship.

16.2 Vendor risk attitudes

Vendors are usually small, non-diversified, severely resource constrained, and as a consequence are rarely risk neutral. Their attitudes to risk can vary widely over time, and across sourcing environments. As we know, vendors are risk averse when they are willing to settle for a lower profit for certain than what they might obtain as expected profit from a risky sourcing. In other words, they give up some profit to avoid risk. They derive a utility from a smaller but certain profit that is equivalent to expected utility from an uncertain bidding competition. When sellers are risk averse they would prefer a payment scheme that reduces uncertainty in their profits.

The utility level must be the same for vendor indifference between two procurements, although one may yield a higher expected monetary profit. Clearly there is a risk premium that balances the difference in expected profits. Recall that risk premium is the reward amount the vendor is willing to let go in order to avoid risk, i.e., its insurance rent. Or, equivalently, it is rent the vendor must be paid in addition to its reserve price to participate in a risky sourcing. These two risk premiums are identical, as they should be, for constant absolute risk averse or CARA vendors. Explicit recognition of a risk premium is key to designing the appropriate sourcing arrangement that provides incentives for cost control, as discussed in §7.4. The linear incentive contract is a prime example. When vendor private information disallows direct monitoring of cost control by buyers, the so called moral hazard problem exists. The next chapter discusses in detail the relationship of moral hazard, risk premium and contract design; here we are more concerned with the incentive contract's relationship with resource sharing.

16.3 Vertical resource and risk sharing

Strategy Query #26 *– Why should buyers share resources with suppliers?*

What forms of investment follow when a vendor is selected to supplier status? Sourcing programs involve production capacity improvement and productivity improving resource allocation following the selection decision. Most selected vendors must upgrade to OEM standards with investments in the manufacturing process. Investment in quality is a huge issue in vendor development, and collaborative technology solutions are available that cut down the time-to-design. Collaborative design and collaborative planning are forms of resource transfer. Retailers as well as manufacturers are advised "to collaborate more to prevent channel conflicts." While manufacturers are enabling customers provide design inputs for new products, retailers must be in on the act as well. But collaboration

requires management, financial commitment, and investment in time, people and effort. Suppliers are averse to making transaction-specific investments with long recovery periods, and are often constrained for operating capital. Where does the resource come for these investments? Direct investment by buyers in supplier assets is not an appropriate solution in a competitive environment.

Collaborative arrangements

Hyundai, as an OEM in the auto industry, provides resources for local vendor development in castings. The rejection rate for castings could be as high as 10 percent in emerging markets. The OEM had given suppliers its own tooling machinery, and employees trained shop-floor staff in supplier facilities *(Source: Business World, 16 April, 2001; Page 51).*PTC Oracle and Windchill are some providers of collaborative technologies. Tighter collaboration will enable the parties to cooperate in such areas as sales promotions, and share the information on customer preferences that will improve future products. And the collaborative business processes required must be built from integrated IT applications...such as customer relationship management, collaborative planning forecasting and replenishment systems *(Source: Traffic World, by Ken Cottrill, April 2001).* The Chief Procurement Officer (CPO) at Chevron Corporation, identifies future areas for purchasing and supply management in general and in his organization in the following way: "Increased integration of suppliers into the business (integrated work processes, standardized specifications, shared equity arrangements) is a goal..." *Source : "One on One: An Interview": The Journal of Supply Chain Management, Winter 2001. P 3.*

Why does investment cause problems for the buyer? Sourcing officers attempt to ensure that competitive sourcing is not jeopardized by pre-commitments to long-term relationships. Yet, often necessary investments are beyond financial resources available to individual suppliers prior to realization of program profits. Awareness of this problem is acute in public sourcing sectors, where "progress payments" are necessary to keep small suppliers in business.

Progress payments: The sourcing program could have a long life cycle, and this makes progress payments more important for small suppliers. Clear milestones are identified as markers of progress in project completion, and payments are prorated and made. Progress payments are subject to gaming problems as the actual cost of completion until the milestone is not audited or expensive to monitor. It then is advantageous for a supplier to inflate the incurred cost. Moreover, excess payments cause losses in interest revenue even though balance payments may be lower for a legitimate audited final payment.

The risks and constraints are especially problematic when the product or service involves uncertain costs that buyers may have to cover in progress payments. Contractual mechanisms for risk sharing, such as the incentive contract, help in sharing the burden of risk due to uncertain costs. However, resource constraints complicate the distribution of risk in the incentive contract, since whether the buyer or the seller pays for investment will affect incentives for cost control.

Strategy Query #27 *– Are all forms of financial resource sharing equivalent?*

Equity versus debt: Why doesn't the vendor borrow money for upfront costs? If there were an internal spot money market, this supply chain could create efficient loan and debt systems to allow optimal allocation of resources. Thus, the upstream supplier could take a loan and optimize its material resource planning, and the downstream buyer could provide the loan and optimize its capital assets. Both could buy and sell debt in the efficient internal money market. In the absence of such a spot money market or in the situation of private information (asymmetric information both between the money market and the chain, and between participants in the chain) design of appropriate sourcing mechanisms becomes a challenge. The biggest problem is that debt disturbs the risk sharing arrangement that has been so carefully balanced with the incentive contract. The risk management approach adopted by vendors and the buyer is ruined.

If debt is used, the risk sharing arrangement becomes skewed. If Supplier D cannot raise money from other sources, Buyer D who seeks to help its supplier with the resource constraint will provide necessary resources as a loan at the desired rate of interest. Buyer D will need some assurance the loan so made will be fully recovered at the completion of the program, and Supplier D shoulders the entire risk.

An equity or profit sharing approach will retain the risk allocation. This chapter describes an equity approach that helps solve Supplier D's resource constraint problem, based in the risk sharing mechanism inherent in the incentive contract (see Chapter 17 for details on the incentive contract). The proposed approach will enable Buyer D to integrate its financing of operating or investment capital for Supplier D into the sourcing contract without disturbing the incentive contract's risk-incentive tradeoff for Supplier D's cost control. Actually, our strategy employs equity for a dual purpose: for the recovery of Buyer D's resource transfer to Supplier D *and* as a signal for Supplier D's private information on cost; but more on this later.

The key advantage of equity over the straight debt relationship is due to the nature of profit sharing. The risk burden due to uncertainty in contract cost for the contract can remain distributed between Buyer D and Supplier D in a manner determined by the sharing rate of the incentive contract, since equity assures Supplier D gets a fixed fraction of the original profit.

We may conveniently view the sourcing program in two periods. Buyer D has to make the investment in the first period. The resources actually used by Supplier D will not be verifiable by Buyer D, who can at best tell the most it

should make available to the supplier. At this time the incentive contract is in place, and Supplier D has a cost estimate but also has plans on investments that would reduce this to a lower cost estimate. In the second period, Supplier D hopefully has invested the advanced funds in cost reduction, and has fulfilled the contract and both parties know audited final cost for the contract.

Buyer D can make investment as equity financing in period one and expect to recover the whole amount in period two. The manner in which this is accomplished is for Supplier D to return to Buyer D on contract completion a predetermined fraction of the contract profit. Our recommendation is that the amount Buyer D advances in a lump sum should not exceed the amount that it expects to be returned through the equity share. The advantage of this arrangement is apparent. Supplier D obtains all its required investment prior to undertaking the contract for Buyer D, who can fully expect to recover the amount it has provided upon completion of the contract.

Sharing profits and supplier finance

In 2001, General Motors sent letters to suppliers offering a 65%-35% split on savings derived from model redesign that reduced costs. This was a dramatic change from the authoritarian demands from suppliers that GM earlier practiced. ...

Suppliers were under financial duress and traced it to procurement practices. They needed to finance purchase of tool steel and labor with loans that needed to be repaid in 90 days.

Source: Smock, Doug. (2001). General Motors launches new purchasing approach. Purchasing. Feb 22, Pg 22.

With this strategy, the investment risk is shared between Buyer D and Supplier D in proportion to the incentive contract, just as the cost risk is shared. Since all resource sharing is done and recovered within the purview of the incentive contract, Buyer D is at liberty to terminate or continue business with Supplier D in future sourcing. In sum, overall risk management is improved since resources are treated as allocated within the contract rather than across contracts.

It is a significant advantage that other contracts do not get unjustly allocated joint costs, a likelihood when subsequent contracts have higher cost reimbursements proportions. We discuss this problem in Chapter 14. Investments in cost reduction debited within a contract as discussed here help avoid this problem.

16.4 Buyer's discounted profit share

***Strategy Query #28** – How can the buyer recover its advanced resources?*

How much resource should the buyer advance? This depends on the arrangement that requires Supplier D to return to Buyer D a portion of gross profit from the contract. The parties may formalize the arrangement by means of an equity holding in the contracted project offered Buyer D by Supplier D. The strategy amounts to the creation by Supplier D of a sub-company for the execution of the contract in which Buyer D and Supplier D are sole joint stock holders.

Supplier D's profit from the program is a linear function of the cost under- or over-run. In the absence of any resource sharing in period two (when cost is audited) Supplier D gets a gross profit given by the linear incentive contract. Knowing the proportion of profit retained by Supplier D in period two, the proportion returned to Buyer D as its complement is also known. For a known interest rate per period, Buyer D's net present expected value of this recovered profit in period one is known. The advanced resource should be no more than the portion of profit shared with Buyer D discounted to the first period. Buyer D is therefore willing to finance investment in the program to this discounted limit.

Strategy Query #28 *– Why should supplier claims about its private cost not be credible?*

There is one difficulty in effecting such an arrangement. The initial target cost for the contract that the LIC used should be replaced with the improved target cost after investments in productivity enhancements. Yet there is no reason why Supplier D would faithfully convey the true improved cost estimate for the project. As this is private information Supplier D may have an incentive to actually misrepresent the cost reduction or productivity improvement. However, this is also critical information for Buyer D in period one, who is trying to decide how much financing to make available. An argument could be made for Supplier D to claim that huge profits were possible due to very large improvements and low final costs (now that the award is over and investment is being made), and therefore argue that large investments by Buyer D in its (Supplier D's) facilities would be viable.

Buyer D cannot verify this, and will only know the true cost after an audit at the termination of the contract when uncertainty confounds the true expected cost in any case. If the buyer uses a naïve strategy it would recover a much smaller portion of the original investment at the conclusion of the contract, since actual costs would greatly exceed Supplier D's claimed cost. The supplier would almost surely see that this occurs. To be credible, Supplier D must find a signal of its estimated cost for Buyer D in period one itself. A signal is a communication that is optimal to use when the buyer is known to be interpreting it correctly. In our strategy, the equity share of profit from the incentive contract can and must do double duty as a signal of the estimated cost.

In sum, the fact that Buyer D does not know the revised cost estimate when making funding available, though Supplier D privately knows it, gives Supplier D an incentive to misrepresent the estimate since a lower estimate yields potentially higher funding. Hence Buyer D will have to see a signal that allows it to deduce

the revised cost estimate correctly. Since Buyer D does not have perfect information on revised cost estimate even later on auditing, it must find another way of decoding a communication from the supplier. In our strategy the imputed Supplier D's revised cost estimate is mapped from the profit share retained by Supplier D in period one. Then, Buyer D can assess its recovered discounted expected value of profit in period one using the imputed cost estimate. It thereby rightly assesses the amount of funding to provide for possible investment.

16.5 Supplier's discounted risk adjusted profit share

Supplier D seeks the most financing that is available from Buyer D, so it takes this entire amount offered. Actual use of financing is not observable to the buyer, and is under the discretion of Supplier D, who may hold some amount as risk less assets (cash). Trading in financial markets with excess cash is prohibited in our strategy, but it may earn interest until period two. Supplier D's net profit in period two, when this kind of resource sharing is enjoyed, is its profit share and whatever residual cash and interest has accumulated.

Recall that Supplier D's preferences from profits are risk adjusted to utilities as it is a risk averse firm, facing uncertain costs in period one. Supplier D's expected utility is thus on par with its utility for discounted profit less risk premium. It is usual to express risk premium proportional to variance in profit arising from cost uncertainty and proportional to the average risk aversion constant. Now variance in cost (and consequently risk premium) depends on the supplier's LIC sharing rate, the equity share, and the discount rate.

The optimal choice of equity is the proportion of equity retained by Supplier D that maximizes its expected utility. This yields the condition for how Buyer D should do its imputation or mapping of equity to estimated cost, and how Supplier D may choose an optimal equity as a function of signaled cost.

16.6 Equity signal of cost (Advanced topic)

***Strategy Query #29** – Is the equity financial arrangement capable of credibly communicating private cost?*

Our strategy uses equity for fund transfers and for a signal.[1] What is the ability of equity to serve as the required signal? We investigate this answer next.[2] As a starting step Supplier D offers an equity share. Let us suppose that Buyer D imputes a cost figure to Supplier D's private cost estimate on the basis of this equity share offered by Supplier D. This can easily be done by a schedule that returns a cost for each equity share.

If this imputed cost turns out to be truly Supplier D's private cost estimate, Buyer D has a basis in the expected profit for deciding what amount to invest in Supplier D in period one. Knowing that Buyer D is inferring a cost estimate from

the equity share, Supplier D ought to have no incentive to deviate from its selected equity share. Our strategy will work when such an imputation schedule can be found, where an equity share returns an imputed cost same as the true cost when Supplier D maximizes its utility. When the true cost is anything other than this imputed cost, supplier D's utility declines.

With the signaling schedule an equity share can serve as a credible signal of estimated cost for the program. Then Buyer D has a viable approach, one in which its prior cost estimate can be updated with an *equity-cost signaling schedule*. Supplier D has no incentive to deviate from this equity share signal when Buyer D is known to be interpreting the signal correctly (Spence 1974).[3]

The sourcing environment uniquely characterizes the signaling schedule. The vendors have costs in a given range; and Buyer D sets the lower and upper cost estimates to correspond to the upper and lower equity limits in the signaling schedule, respectively. This calibrates the signaling schedule, and relates a cost estimate uniquely to each of Supplier D's chosen level of equity. Buyer D is now in a position to set the limit on the amount it will provide to Supplier D for possible investment. Recall that the limit is equal to the present value of the share of expected profits that will be returned to Supplier D. The maximum investment that will be recovered by Buyer D is its discounted share of the LIC profit, with imputed cost from the equity signal used for revised cost estimate. Since recovery is through equity shares or strategy maintains the risk-incentive properties of the contract.

Pooling equilibrium: It is possible that Supplier D doesn't want to be informative of its revised cost estimate, and finds a "pooling equilibrium." This is equity of a hundred percent. Here all cost estimates correspond to the same equity, i.e., a hundred percent, and the signaling schedule fails to distinguish costs. Therefore, equity is independent of cost estimate and knowing this, private cost could be anywhere in its feasible range. The best estimate Buyer D can make of the seller's private cost is based on its prior estimate of its supplier's revised cost estimate. In any case, strategic behavior is clear. Buyer D will provide no advance funding if Supplier D chooses a hundred percent equity.

Separating equilibrium: When Supplier D doesn't defeat the purpose this way, it chooses less than a hundred percent equity in the allowed feasible range. The firm prefers this "separating equilibrium" to the pooling equilibrium when its utility given the signaling equilibrium is higher than with the pooling equilibrium. Firms prefer the separating equilibrium to the pooling equilibrium when their revised cost satisfies the condition that it is less than some threshold.[4]

In our strategy, the signaling schedule gives the separating equilibrium equity; and equity of a hundred percent is the pooling equilibrium. Supplier D will benefit from switching to the pooling equilibrium when its estimated cost rises sufficiently high. At that level costs of signaling exceed benefits. If this threshold exceeds maximum of the range of expected costs, then Supplier D will always prefer to signal using the schedule. Clearly, this is the situation Buyer D would prefer.

16.7 Conclusions

Resource sharing in the supply chain is likely to lead to efficiencies by overcoming bottlenecks in supply. Investments in productivity gains by suppliers that would otherwise not be made are enabled with vertical resource sharing. Yet strategy should remove incentives to misrepresent cost efficiencies, or impose additional risks. Once the supplier is selected and an agreed linear incentive contract (LIC) is in place, the sharing rate and target cost allow risk allocation (Samuelson 1986).[5] Investments must allow productivity gains without changing the balance of risks. The buyer maintains the risk-reward balance by maintaining the original LIC sharing rate and revising the target cost based on the equity signaling schedule to the revised cost estimate. It makes advance funding to the discounted recoverable amount from equity sharing, and expects to recover its interest adjusted investment with its profit share once the project is complete.

The ability to change target cost and yet keep the same sharing rate hinges on credible communication of improved cost. Recovery of investment without disturbing the balance of risk-reward in sourcing is a strategic challenge. The supply chain can gainfully employ a signaling strategy based on equity sharing and the LIC.

16.8 Strategy Query Checklist

The strategic queries answered in this chapter address the ability of the buyer to share financial resources without distorting incentive risk arrangements in sourcing. Queries were:

- *#25 – When are long-term financial relationships with suppliers avoided?*
- *#26 – Why should buyers share resources with suppliers?*
- *#27 – Are all forms of financial resource sharing equivalent?*
- *#28 – How can the buyer recover its advanced resources?*
- *#29 – Is the equity financial arrangement capable of credibly communicating private cost?*

16.9 Proxsys®: Equity Sharing Contracts

You can decide the value of resources you will invest in your vendor and expect to recover within the program. The pre-existing incentive contract allows you to share risk with your supplier for uncertain production costs. The scenario allows sellers to credibly communicate private information on their production costs to buyers. This is done through an equity share that the seller retains in profit from an incentive contract.

Exercise 6: Your current supplier requests financing for legitimate investment in cost reduction. In order to avoid future pre-commitments, you wish to recover funds at the conclusion of the program. Moreover, you do not wish to disturb the risk-reward incentive structure of the award with loans or debt financing. Therefore, you devise an equity sharing structure for the sourcing program. Here, the supplier retains an equity share of profits, which will indicate to you what would be the supplier's revised cost estimate as the target cost after investment. The present value of your equity share should balance funds you provide the supplier.

In this program, your current incentive contract has a profit fee of 10%; the sharing rate is 10% and target cost is 1.5 m. The supplier's risk attitude is captured by the constant 1.0 (if it was 0, the supplier would be risk neutral); the program interest rate (determined by the annual interest rate and duration of the program) is 1%. The supplier could choose a range of equity to retain from 60% to 100%; however, it chooses an equity of 80%. You estimate costs to range between 1.1 and 3.0 m.

Further questions: If the range of equity that covers the cost range is 10% to 100%. What equity should the supplier offer for an actual cost of 1.8 m? What should the buyer then invest in the supplier? What is the optimal equity to offer if the supplier is more risk averse, at risk aversion constant of 2?

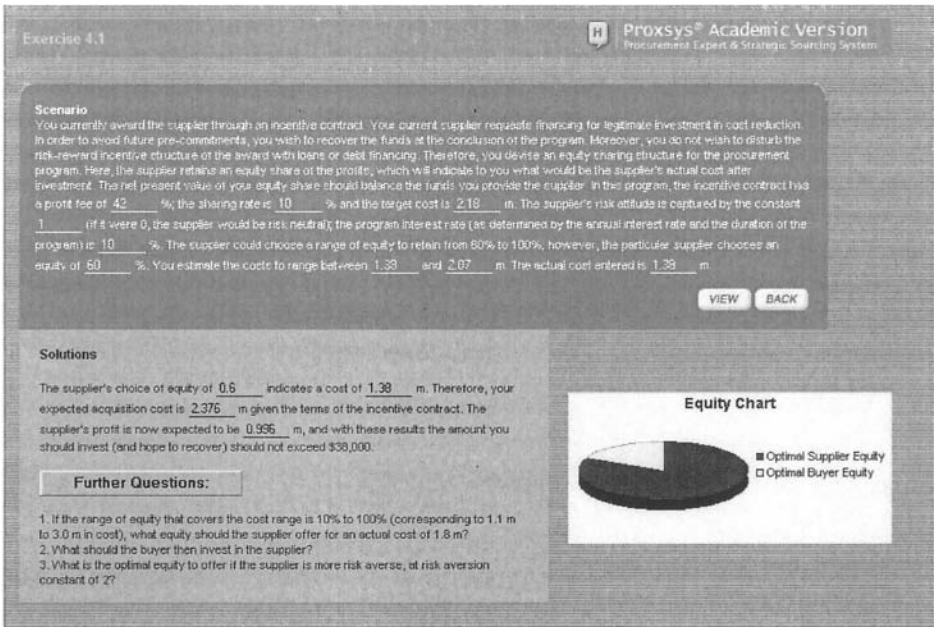


Exhibit 16.1: Exercise 4.1 on Equity Sharing Contracts. Data is picked up from the sourcing environment, but you can make changes.

17: Selection and Incentives for Innovation: LIC

17.0 Introduction

For the most part goods such as maintenance, repair and operations (MRO) items are related to spot market prices. Sourcing is non-strategic in these cases. For new product launches, prices are usually adjustable in the short run by suppliers due to the accumulating experience with the quality and volume of goods sold. However, buyers perceive direct industrial goods such as sub assemblies and design and engineering projects to have less easily adjusted prices. In several instances, price is the deciding element in whether the supplier wins the award and rivals have hotly contested the target price. Often only one initial opportunity at the time of selection is available to the industrial supplier to set a contractual price that must be adhered to over a longer term (Rajgopal and Bernard 1993; Riordan and Sappington 1989).[1]

Product and process innovation from technological change during the course of the contract affect costs. They introduce asymmetries in information on productivity and capacity, and are confounded with uncertainties in realized cost. Moreover, the supplier may control some of these improvements in productivity and capacity through its spending on innovations as the last chapter demonstrates. The crucial aspect of this supplier effort is that it is not generally verifiable and therefore not contractible. How can the buyer exploit opportunities that originate from suppliers for innovations and design enhancements? In sum, information environments with unverifiable actions raise further questions on incentives and complicate sourcing strategy.

Innovation is critical to downstream competitiveness of the buyer, and is often the major reason why it engages in outsourcing. A simple fixed price strategy is inadequate when sourcing innovative products and services. Specifications of sourced items change, designs change and performance requirements are moving targets. Fixed prices are usually abandoned with these changes. Yet cost reimbursement arrangements are not adequate replacements. Suppliers need incentives to take opportunities that reduce prices. This chapter discusses the role of the linear incentive contract (LIC) in accomplishing these ends.

Outsourcing innovation
An estimate of the average amount of innovation from sources outside the company is 45%. Pharmaceutical firms turn to small biotech companies for research breakthroughs. Chemical companies strengthen staff with offshore contract scientists and stretching R&D budgets. Pharmaceutics companies track the profitability of drugs according to whether they were developed internally or outsourced
Source: Linder, J.C., Jarvenpaa, S., and Davenport, T.H. (2003) Toward an Innovation Sourcing Strategy. MIT Sloan Management Review. Pp. 43-49.

17.1 Design and Production

Often sourcing innovation can be separated into design and production phases. Not all suppliers who excel in design are best for production. The nature of supplier effort differs in these two phases; and the nature of risks and costs are different as well. However, most strategic prescriptions fail to distinguish between these two phases. They are subsumed in order to bypass difficult questions of technology transfer of design and development to production. More sophisticated buyers decouple selection and motivation of suppliers in each phase, and use performance in the earlier design and development phase for later production selection and allocation arrangements. More sophisticated sellers, likewise, anticipate production gains and adjust their strategies. In short, strategic sourcing of innovation requires attention to selection and performance in both the design phase and the production phase of the sourcing agreement.

Anticipated incentives in production contracts distort the supplier selection process for the design phase, and strategies that provide the integrated view over two phases are less well understood. Distinguish between design phase benefits and costs and production benefits and costs. A supplier can incur higher design costs in order to arrive at a lower production cost. Design costs can lead to more valuable prototypes and experience with developmental production of a selected prototype prior to planned production would normally bring steep learning curve production cost declines. When single source arrangements are in place there may be a justification to combine design and planned production costs; but when multi sourcing buyers should have separate awards for separate phases. In this chapter we combine the two types of costs into a single uncertain target cost for a benchmark closed sourcing strategy. Here the buyer awards both design and subsequent production to a single source. In the next chapter we distinguish between the two costs for an open sourcing strategy where the buyer strategically decouples design and subsequent production.

What sourcing arrangements reflect an integrated view of design-cum-production sourcing? Sourcing strategy must integrate selection and incentive risks and rewards in the earlier design phase to risks and rewards from the production phase. Recall that with risk averse suppliers, strategies based solely either on fixed price contracts or cost plus contracts are inadequate as they ignore

burdens of insurance or disincentives to effort. Sourcing strategy must allow new incentive forms for price discovery in innovation, such as the *linear incentive contract* (LIC). What are effects of LIC forms on selection risks from competitive bidding? The last chapter introduced the impact of risk averse attitudes for a key aspect of incentives management in sourcing: that of resource sharing and credible communication in sourcing governed by LICs. This chapter extends understanding of how risk attitudes impact innovation and cost control in bidding contexts. Therefore, this and the following chapter consider reverse auction-contracts interlinkages beyond fixed price arrangements of Chapters 13 and 14. We begin this chapter we begin with how risk averse vendors' bidding strategies can affect and be affected by the LIC form (McAfee and McMillan 1986).[2]

17.2 Selection environment

A typical scenario involves an integrated original equipment designer (OED) and original equipment manufacturer (OEM) as the integrated "buyer". The same agency or firm will source both design and development services, and production services at different times in a sequenced fashion. This Buyer E as the OED/OEM depends on innovative sourcing arrangements. In particular, there is a key sub-assembly it is planning to outsource or re-outsource as it expects supplier innovation will help. Two of the prime contractors on its qualified supplier list are Supplier E and Supplier F, and they will compete against many other suppliers in the supply base for selection in a reverse auction. In this scenario we consider the sourcing contract with one winning supplier, say Supplier E, as a single source contract for both design and production phases. The LIC is a form of single source contract between the two parties: buyer and seller. Recall the parameters that fully define the LIC – the target cost, the profit rate on this target cost, and the sharing rate for cost over-or under-runs.[3] In the next chapter we consider another form, a dual source contract that links two winning suppliers, Supplier E and Supplier F, to the buyer for the design phase and possibly the production phase as well.

17.3 Cost structure

Strategy Query #30– *How do common and specific cost drivers affect the supply base?*

The supplier's residual cost uncertainties differ with types of cost drivers, and its ability to control uncertain costs will differ as well. When Supplier E uses bid-pricing for risky contracts it factors in its required insurance margin (risk premium). The LIC gets the supplier and buyer to share this burden of risk. We may conveniently classify the many items that comprise the bill of quantities for

sourcing into two main categories. Those that have cost drivers that are common across suppliers, and those that have cost drivers that are specific to a supplier.

Common costs derive from a variety of drivers, such as inputs from common tier 2 suppliers, commodities purchased from common sources, and so on. The working cost of capital is a large common cost across the supply base that may fluctuate during the course of the contract. The indirect and overhead fixed cost of capacity is a common cost as equipment and facilities costs are similar across the supply base. Many of these common costs of capacity are joint costs across multi-market business for the supplier. Therefore common costs relevant to the sourcing program are largely allocated joint costs (Cohen and Loeb 1990).[4] It is a strategic cost accounting decision of suppliers to allocate joint costs to sourcing business. Recall that §14.10 discussed how contractual cost sharing changes the level of total multi-market input costs suppliers find optimal. For a particular LIC the same norms for allocation of joint cost to the contract would likely be observed by all suppliers. The allocated joint costs from these input costs are common costs across the supply base. LICs work best when these common costs are minimal.

In contrast, specific costs derive from proprietary knowledge, unique productivity enhancements and idiosyncratic engineering and management activity. Private costs typically represent uncertain variable costs: direct costs in labor hours and direct materials costs. These could vary greatly depending on the firm's productivity, variable levels of other business, and the cost accounting orientation of the firm. Buyer E and its suppliers can assess uncertainties and are able to assign parameters of the probability distributions of all random variables (Harrison 1990; Newman 1989).[5]

The innovation is mainly in the design and development phase. The combines uncertainties of the cost types together contribute to the risk of sourcing. While both kinds of cost are present in both phases, common costs and overall uncertainties are larger in the design phase, while specific costs dominate in the production phase. Advantages of imposing this classification to the cost structure will be more apparent to the reader in the next chapter with dual source contract forms. We will use this classification in this chapter for two reasons. First, it enables comparisons between the single source LIC discussed in this chapter with the later dual source contract forms. Second, it reveals the major limitation of LICs that is due to strategic joint cost allocation.

17.4 Effort

***Strategy Query #31** – Why should suppliers spend on cost control effort?*

Each vendor can do various things to reduce design-cum-production cost. In the case of common costs, technology standards suppliers adopt have an important role. Effort is directed at design improvement for manufacturing ease, and better materials for lifetime cost reductions. Effort also is directed at reducing

commodity prices by taking options at the right times, flexible manufacturing, and developing low cost international sources. For common cost reductions effort is also well spent at better working capital and capacity management to reduce joint cost allocations to sourcing business. The fraction of joint cost allocated to sourcing would be less when effort is directed at increasing business in alternate markets addressed by Supplier E (Cohen and Loeb 1990).[6]

In the case of specific costs, Supplier E or Supplier F or other suppliers can engage in due diligence to improve their productivity. Effort towards specific supplier cost reductions reduces costs of direct labor and materials, and improves internal production efficiencies.

The overall effort moves suppliers along the learning curve and reduce design and development contract performance cost. However, effort itself costs money, which is not reimbursed by Buyer E since it cannot be verified or contracted. The unobservable and unverifiable nature of cost control effort expended by suppliers is no doubt a big problem for innovation sourcing programs. The asymmetry of information on costs and cost-control effort between vendor and buyer complicates provision of appropriate incentives to Supplier E to exert hidden or unverifiable cost control effort. Uncertainty itself is a problem for suppliers as well, as investments in innovation effort is an ongoing expense incurred prior to realizing production cost estimates.

Initially all rivals in the supply base are equally uncertain about their design-cum-production costs. From Buyer E's viewpoint these cost components are very expensive to separately observe. Any strategy aimed at providing the right incentives for innovation effort would be ignorant of separate magnitudes of common and specific cost components. Strategy must base its compensation scheme on the combined innovation cost. The next sections discuss incentives for performance available with incentive contracts for the single source bidding competition.

17.5 Performance in the single source incentive contract

Buyer E may use a single source LIC for the design-cum-production contract. The closed strategy requires that the subsequent planned production phase profit is discounted and combined with the design and development phase profit by the single supplier for a unit contract. Target cost is therefore expected target cost for the entire planned design-cum-production project. Suppliers base their expected bid profit fee during the selection competition on this expected target cost.

The hallmark feature for incentive risk of the LIC is that cost over- and under-runs are shared in accordance with a sharing rate. This shifts the burden of risk in sourcing programs between buyer and seller, and generates risk premium fees and effort fees. To understand these fees, we must distinguish between separate revenue that suppliers directly get paid, and Buyer E's agreed share of the cost burden from contract cost.

Supplier E's revenue itself has several component fees or rents. It is comprised of its reserve profit, its agreed share of contract costs, its disutility costs of effort, and its risk premiums or insurance costs.

Buyer E's share of cost is a direct audited payment by Buyer E, and is the entire actual cost for the cost-plus contract, or a portion of it for the incentive contract. Buyer E's acquisition cost is what it pays to suppliers, both as revenue and as its share of cost.

Why should we distinguish between revenues and costs? The distinction is necessary as Buyer E reallocates performance risk with the two types of payments. For the fixed price contract all risk is Supplier E's, since Buyer pays no share of cost. Therefore, the revenue has a larger risk premium component and a larger disutility cost of effort. For a cost plus contract all risk is transferred to Buyer E, who has the entire cost component; but Supplier E revenue requires no share of cost, a negligible risk premium and no effort disutility.

Clearly, contract type re-allocates fees for risk premium and cost shares from revenue paid to costs reimbursed. This affects effort costs and effort chosen. It is easy to see how Supplier E's choice of effort optimizes its profit. For the cost-plus contract zero effort is optimal as its profit is unaffected by effort; and for the fixed price marginal increase in effort costs balances marginal decrease in cost affected by effort. The impact of risk is less clear for LICs. Supplier E's effort strategy is therefore less obvious with LICs and begs the question of how to minimize acquisition cost (Samuelson 1986).[7]

***Strategy Query #32** – What is the preferred sharing rate?*

Buyer E trades off selection risk and incentive risk to achieve its best acquisition cost. Our strategy is to design the incentive contract with a sharing rate that achieves the optimal tradeoff between these risks, and use the Vickrey award to set the target price (Laffont and Tirole 1987; McAfee and McMillan 1986; Seshadri 1995).[8]

17.6 Selection risk fees

We now take a deeper look at risks and associated fees. The risk averse vendor when faced with a business gamble will seek insurance. This well known behavior is illustrated in Exhibit 17.1.

In competitive selection situations the vendor is faced with selection risk and will pad its bid with selection risk premiums as additional fees. Expected utility maximizing behavior in bidding competitions requires that the vendor adjust its monetary profit approach to bids with selection risk premiums. In effect Supplier E translates reserve price to reserve utility by relating its margin over uncertain cost to a utility required for its bid. Supplier E can easily determine its actual bid price by a reverse scaling from a bid utility to a margin over cost.

***Strategy Query #33** – How does selection risk determine acquisition costs?*

What are the separate component fees or rents that the vendor requires in order to participate in the selection competition? Buyer E must compensate the supplier for (a) reserve utility of information rents adjusted opportunity cost; (b) its cost of effort; (c) its share of expected effort adjusted costs as determined by the sharing rate of the LIC; (d) its risk premium from the uncertain share of its cost.

The first of these comes from the vendor's net reserve utility plus its economic rents from its private information on reserve utility. In a direct incentive compatible reverse auction, the vendor reveals its target price corresponding to its reserve utility but will be promised the higher payment of the lowest rejected bid (in a single source Vickrey reverse auction). In the sequel, we will loosely say that a vendor bids its utility with this understanding.[9] So the information rent adjusted opportunity cost is the certainty equivalent of the expected second lowest bid utility. The additional three terms raise compensation required for vendor participation in the selection competition. These last three components are identifiable and separable for CARA vendors facing normally distributed costs, and must be minimized by appropriate selection of the sharing rate in the LIC. Buyer E therefore focuses on this portion of the selection risk (McAfee and McMillan 1987).[10]

The vendor seeks to reduce its selection risk in order to increase the probability of winning the bidding competition. What are the ways it employs to reduce selection risk? Our strategy offers three main ways to do so.

1. The opportunity cost utility the vendor bids in an incentive compatible reverse auction should be its reserve utility. In other words, utility from the LIC bid-profit should be no higher than spot market utility. As the LIC reduces the cost distribution in the supply base, it increases intensity of competition. Vendors have to bid more aggressively to be selected. This will help to minimize selection risk. Further, Supplier E increases its chances by reducing this alternate utility, which corresponds to an opportunity cost. A better management of its capacity in order that it does not have to sacrifice business from spot markets for sourcing business will help. Options on inputs lower its own outsourcing costs and helps create flexible capacity.

2. Supplier E should improve efficiency of effort in costs reduction. Cumulative experience with production has an established impact on unit costs, and Supplier E should seek learning or experience curve advantages.

3. It should enhance the amount of effort in innovation and productivity of innovation exercises. Better management of new ideas in cost control from employees and production teams are always welcome.

4. Supplier E should seek to reduce their vulnerability to risk. Risk of bankruptcy for smaller vendors rises with dependence on a single buyer, and with dedicated resources in volatile markets. Conversion of fixed costs to variable costs helps avoid the need to absorb fixed costs when business is in a downturn. Better outsourcing practices for indirect costs by vendors at the second tier of the supply chain serves to reduce risk as well as improve costs.

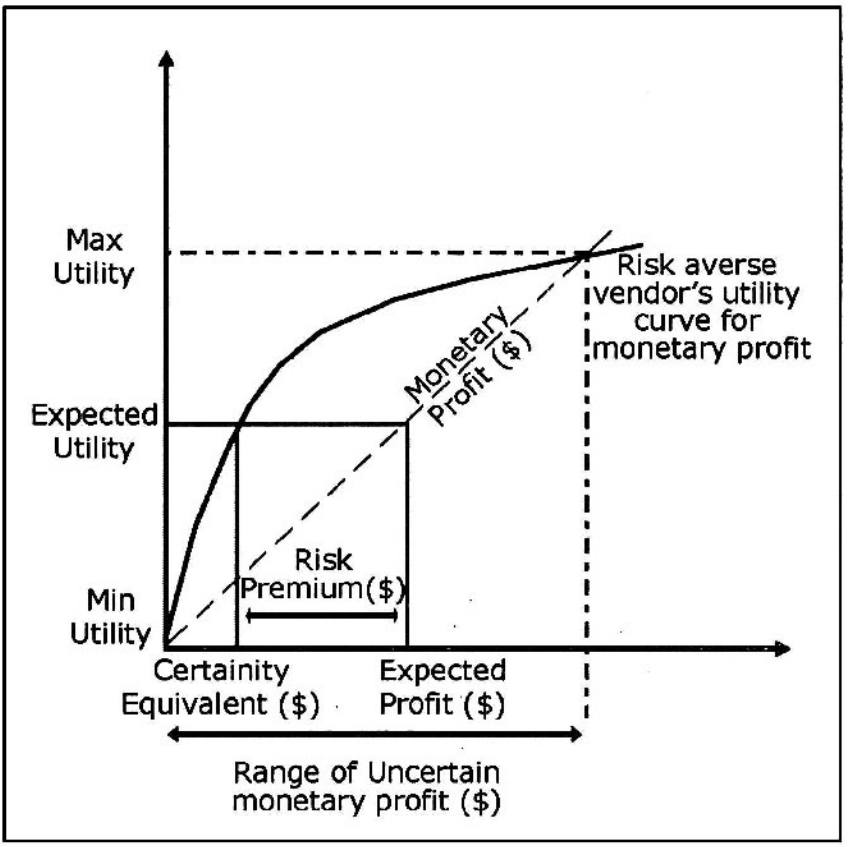


Exhibit 17.1: Risk averse vendor's insurance rents. The schematic diagram depicts the relationship between uncertainty in profit, risk premium and certainty equivalent. A greater uncertainty for a given expected profit drives the risk averse vendor to settle for a lower profit for certain.

17.7 Incentive risk fees

Strategy Query #34 *– How does incentive risk determine acquisition cost?*

The vendor already has an incentive to invest in cost control even if it is risk neutral. Marginal cost of effort is balanced against marginal gain in profit from cost control. The supplier expends some level of effort, therefore, until the cost of additional effort does not result in commensurate profit from cost reduction. The higher the share of cost borne by the supplier, higher the supplier's incentive for cost control.

With increasing sharing rates the vendor requires higher insurance rents. Risk premium rises with higher sharing rates as its variance of cost is higher with

increased supplier's share of costs. Therefore there is a tradeoff between lowered costs due to effort and a higher risk premium due to the shared cost variance. This results in a tradeoff between risk and cost control incentive. The buyer is well aware of this tradeoff. By making the LIC more risky for the vendor the buyer provides additional incentive for cost control. But there is no free lunch. The vendor has a higher risk premium or need for insurance rent that pads selection risk discussed earlier.

Also, as variance in cost will increase when the vendor bears a larger portion of cost, aggressiveness in bidding decreases. This adds to its bid price, and the amount of revenue the buyer pays to the vendor. Acquisition cost therefore depends critically on the balance between incentive risk premium, marginal cost of effort and value of effort in cost control and bidding effects.

Recall that Buyer E chooses the sharing rate of the LIC to minimize its acquisition cost; and that acquisition cost is simply the sum of Supplier E's revenue compensation and its cost reimbursement compensation. This last fee is the fraction of effort-adjusted costs borne by Buyer E as determined by the agreed LIC sharing rate. There are correspondingly four components (that look very similar to the ones mentioned earlier in §17.6) that make up acquisition cost: (a) award price corresponding to the Vickrey award bid utility; (b) cost of effort; (c) the sum total of effort-adjusted cost; and (d) insurance rent or risk premium. Notice that only term (c) is different from before in §17.6, in the vendor's compensation. The difference is that Buyer E pays the entire cost, partly in the revenue payment in selection fees and partly as reimbursement in incentive fees, and reflected in acquisition cost.

The optimal sharing rate can affect the last three terms. We therefore call the last three terms incentive risk fee terms. Optimal sharing rate balances marginal reduction in cost with marginal increase in cost of effort and marginal decrease in risk premium. Thus, these last three terms that follow from incentive risk fee determine the buyer's choice of sharing rate.

17.8 Joint risks

To sum up our discussion so far, risk averse vendors behave as expected utility maximizers, rather than expected monetary profit maximizers. The difference is risk premium or insurance rents that intervene to adjust gross required compensation under a variety of uncertain situations in order to deliver the same net expected reserve utility level. The risk averse vendor also is likely to invest more in cost control than the risk neutral vendor. Incentives benefit and costs are balanced by the LIC sharing rate. Vendors try to minimize their selection risk, and buyers try to optimize incentive risk.

Strategy Query #35 – *What tradeoffs exist between incentive and selection risks?*

How to distinguish between selection and incentive risks? By comparing the four terms in §17.6 and §17.7 the distinction is apparent. Selection risk fees represent compensation necessary for vendor participation and include all the four terms in §17.6. Incentive risk fees represent the buyer's intervention through an incentive contract and include the last three terms in §17.7. Symmetric CARA bidders facing common normally distributed uncertainties can separate the components of selection risk and incentive risk.

Constant absolute risk aversion: The vendor selected as Supplier E now owns rights to the business gamble represented by the bidding competition, and faces uncertainties of contractual performance. What if the current winner changes its mind and decides to sell the rights to the supply relationship, with all its performance uncertainties, to another contender? The selling price should be no different from the buy-in price. This is a natural condition of bidding competitions as otherwise the winner would have been better advised to bid a higher price or lower price just moments before the buyer makes its announcement on the evaluation and selection. There is only one risk averse utility function that satisfies the requirement that the selling price be identical to the buying price for a gamble: the exponential utility function better known as the constant absolute risk averse (CARA) utility.[11]

The CARA vendor facing normally distributed uncertainties has the advantage of separable insurance rents. Risks premiums required for selection and incentive risks are separable and do not compound each other. Moreover, common cost and specific cost drivers have separable and additive risk premiums based on variance of these (normally distributed) cost uncertainties. A benchmark case, therefore, is for symmetric CARA bidders with very similar risk attitudes, facing normal uncertainties.

Risk tradeoffs: The buyer designs its optimal contract, i.e., chooses its optimal sharing rate for the LIC, based on joint risk fees; and the vendor chooses its required compensation based on joint risk fees. There is a pass through effect. A change in incentive risk also changes selection risk. Different bidding and contractual arrangements, or sourcing systems, achieve different tradeoffs in selection and incentive risks. For instance, the next chapter examines ways in which the buyer can use other contract forms based in dual sourcing to improve on the incentive risk tradeoff while lowering selection risk for a given supplier. Overall improvement for buyer acquisition cost may well be favorable in comparison to our benchmark single source LIC.

17.9 Implications of Bidding for LICs

***Strategy Query #36** – Why does risk aversion affect bidding for LICs?*

The selection risk even for risk neutral vendors in the single source LIC is different than in the fixed price contract. There is no risk premium as the vendor is risk neutral. Effort expended in cost control in the LIC is lower than for fixed

price contracts as the full penalty of cost overruns is not borne entirely by the vendor. Therefore cost of effort in selection risk fee is lower. The vendor now is compensated for its share of cost rather than total cost. Therefore this term may be lower, even though cost may be higher due to less effort. Remember that total cost is now effort adjusted cost.

But there is yet another subtle change in selection risk fee. This is due to lower variance in relevant effort-adjusted cost due to the shared nature of vendor cost. Lowered variance reduces the information rents possible for vendors in the bidding competition. Vendors have to bid more aggressively and this reduces the award price. The component in the selection risk fee corresponding to information rent adjusted opportunity cost falls relative to the fixed price award. The net effect of these changes to selection risk could lead to a net lowered compensation to the vendor. A better outcome with the LIC for the buyer may ensue than with fixed price contracts even for risk neutral vendors.

In sum, there is a tradeoff with even risk neutral vendors between inefficiency (minimized by the fixed price contract) and information rents (minimized by the cost reimbursement contract). The tradeoff is chosen by the choice of sharing rate in the LIC. This in turn distorts incentive for effort at cost control. Of course, with risk averse vendors the LIC has a distinct advantage. The buyer can control the vendor's risk premium by adjusting the sharing rate that yields vendor cost. The buyer can make this insurance rent substantially lower than that for the fixed price contract. Incentive risk leads to an improved tradeoff than for the fixed price contract. Exhibit 17.2 shows various fees in incentive risks and selection risks, and the tradeoffs for acquisition cost schematically.

Risk aversion in bidding: The reverse auction type also affects compression of award price. Open cry reverse auctions allow information sharing during the price discovery process. For risk averse vendors this means that uncertainty in supply base costs reduction allows them to bid less aggressively, and a higher award price results. A buyer should therefore prefer the sealed bid auction to the open cry auction.

There is another implication of risk aversion in design-cum-production sourcing. Like the two stage source selection process referred to in §9.6, the option exists to award the design stage to one supplier and second source the production phase. We observed there the optimal auction is highly dependent on whether investments were transferable and unobservable. In the case of transferable, unobservable investments governed by LICs the optimal auction even under risk aversion was one that brought divergence between the first and second rounds in two ways : (a) favored the incumbent in a second break out round of bidding, and (b) raise the sharing rate. Risk aversion intensifies these divergence effects. The designs of the next chapter allow extreme cases of divergence between the two rounds: (a) bidding parity in the first round, and favoring the incumbent to the extent of eliminating the break out second bidding round; (b) raising sharing rate from zero for a pure cost reimbursement contract in

the first round to unity for a fixed price contract in the second or production phase.

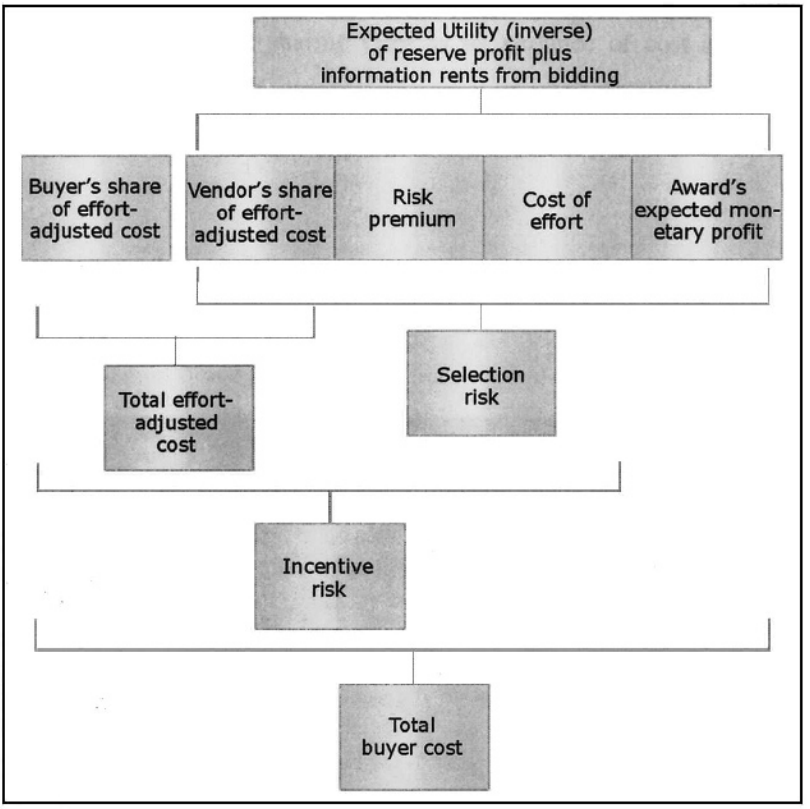


Exhibit 17.2: Components of buyer's cost. Notice that selection and incentive risk share the vendor's effort adjusted cost component. The monetary components of costs, expected profit and risk premiums comprise the vendor's selection risk and correspond to the vendor's expected utility.

17.10 Conclusions

The single source LIC is a popular and useful award for allocation of risk. Flexibility of the contract is due to easily adjusted sharing rate for cost over-and under-runs. Its flexibility ranges from the fixed price contract to the cost plus incentive fee contract. A menu of LICs from which suppliers can self select is the optimal form of contract even when suppliers are risk neutral. When they are risk averse, the LIC is even more attractive. The bid-contract process we discuss in the chapter shows how sharing rate can adjust to achieve the optimal balance from selection and incentive risks. The single source LIC therefore is a benchmark for strategy improvement. The chief strategic limitation of the LIC is its inability to

control joint cost allocations, necessitating cost audits in parallel markets. When common costs are significant better strategies exist as explored in the next chapter. In addition, supplier incentives stem from marginal product based compensation (the linear part in the name), a constraint for strategic sourcing.

Some basic Risk Management Tools from the Bill of Quantities

Through systematic risk management supply professionals can enhance income or reduce costs. These areas for which academic practice has implemented tools in Alcatel (US Business Offices) at the component level for portfolios of components in procurement are:

i. Categories are created on Key Risk Items (KRIs) are grouped in the Bill of Quantities (BoQ) based on risk characteristics. These are reassessed through the procurement life cycle as environments change.
ii. Other categories are on Key Performance Items (KPIs), based on their ability to influence quality perceptions of the product.
iii. A tool creates a matrix of scores for items and categories that can be translated into product-procurement scores for further analysis or decisions on management plans.
iv. A tool could generate a checklist for management interventions in the life cycle of the product-procurement from inception to mass production phases
v. Risk management and performance management plans for ranked items in the two categories are necessary. Supplier selection and contracting plays a role in the management plan, and the tradeoffs with costs involved in these plans are factored into the process.

Source: 5 tools that build solid purchasing risk management procedures. Supplier Selection and Management Report. 4, 4, April 2004. Page 1.

17.11 Strategy Query Checklist

The strategic queries posed and answered here are:

- *#30– How do common (joint) and specific cost drivers affect the supply base?*
- *#31 – Why should suppliers spend on cost control effort?*
- *#32 – What is the preferred sharing rate?*
- *#33 – How does selection risk determine acquisition costs?*
- *#34 – How does incentive risk determine acquisition cost?*
- *#35 – What tradeoffs exist between incentive and selection risks?*
- *#36 – Why does risk aversion affect bidding for LICs?*

17.12Proxsys®: Incentive Fee: LIC

Your program design from the initial scenario of §13.10 will be influenced by vendor risk aversion when vendors are not risk neutral. This scenario allows you to design the incentive contract. Exhibit 17.3 is a typical screen.

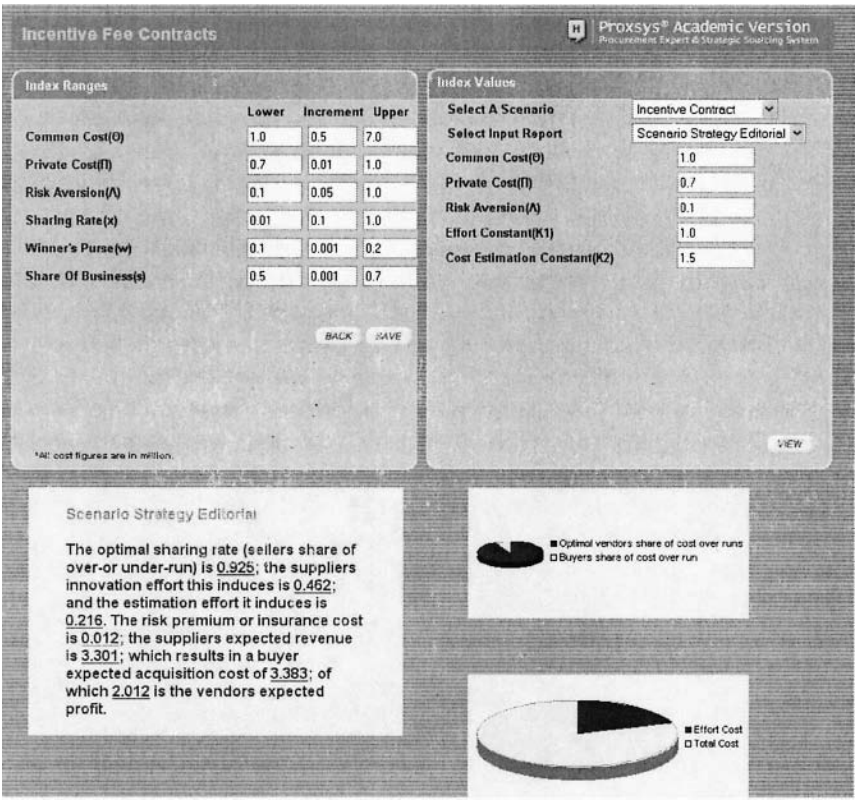


Exhibit 17.3: Incentive Fee Contracts: Linear Incentives. Cost under- and over-runs are shared thereby sharing the burden of risk. The supplier's risk aversion determines the insurance it needs to avoid the burden of risk. The effort constant determines the amount of cost control effort suppliers spend, and cost of this effort to the supplier.

Exercise: The common cost (θ) is 1.0 and the private cost (φ) is 0.7. Risk aversion (λ) is 0.1. Effort constant is 1.0 and cost estimation constant is 1.5. The design of the LIC requires the optimal sharing rate. The strategic editorial answers several additional questions. What is the estimation of the acquisition cost? What are effort costs and risk premiums that will be added to the bids? What profit can the supplier expect? You can access the detailed analysis by clicking on *Further Questions* and selecting the *Incentive Contract* scenario.

18: Selection and Incentives for Innovation: Yardstick Contracts

18.0 Introduction

There are difficulties in using the LIC when joint costs can be allocated to sourcing (as earlier discussed in §14.10). Other difficulties arise when design costs should be distinguished from the net present value of planned production costs for decoupled design and production phases.[1] The joint cost problem arises since suppliers who enjoy parallel markets would find it strategically attractive to both increase overall input costs and allocate increasing proportions of joint costs from spot market activity to sourcing markets and LICs can seriously aggravate the problem. The sharing rate transfers a portion of allocated cost to the buyer, and this means the supplier reduces its own multi-market cost burden. A commitment to single sourcing calls for a strategic response where the buyer reverts to use of fixed price contracts. Then the entire allocated joint cost is again borne by the supplier. While this is acceptable for risk neutral supplier scenarios, as in Chapters 13 and 14, this response is unacceptable for risk averse suppliers in highly uncertain environments. The supplier's insurance costs become untenably high, and the problem of insurance rents is passed on to the buyer through bid price increases that raise acquisition cost (Samuelson 1986).[2] This chapter examines how strategic decoupling of design and production could improve on previous recommendations.

18.1 Dual Sourcing Design

The problem with LICs in closed or coupled design-cum-production arises from relatively higher cost uncertainty in design phases. This leads again to large insurance rent requirements for design costs despite shared risks across all sourcing costs. Open sourcing through decoupling design and production phases could potentially reduce risks. Moreover, dual sourcing the design phase offers more flexibility for design incentives and can induce more design effort. Options to dual source the design phase and subsequently single source or dual source the production phase could result in better risk-incentive tradeoffs. Even with decoupled phases, single source competition for better designs may result in too much effort in the supply base on design. This over expenditure on design

competition can be wasteful when a single source production contract is to follow. Dual sourcing of subsequent production may reduce this welfare reducing competition within the supply base if the buyer desires socially optimal R&D effort (Riordan and Sappington 1989).[3]

The strategic dilemma that comes from compensation based on single supplier marginal product is significant when risks are high, joint costs are allocated, and buyers do not commit to closed or coupled design-cum-production sourcing. The fixed price contract can have poor selection risk results with risk averse vendors, who will add large risk premiums to their bids. The other extreme, the cost plus contract that is common when risk is very high will reduce insurance rents vendors need, but has poor incentive risk results for innovation and joint costs. The single source LIC trades off one problem with the other in such scenarios, and leads to a less than satisfactory strategy. In sum, absence of supplier incentives for effort in better joint cost allocation for design cause severe problems with risk averse suppliers. Is there a better way? The buyer must go beyond single source approaches in design phases to find some way of increasing incentive risk on common costs, while pre-empting selection risk increase through insurance padding.

A deeper look at strategic opportunity reveals that the structure of uncertainties in cost drivers can serve as the basis for improvement. A cost structure as discussed in §17.2 where common costs across sources may be distinguished from source specific costs is key. Supplier compensation schemes based solely on one or the other type of costs could be less efficient. What if the buyer is not committed to single sourcing for both design and production phases? This chapter examines ability of dual sourcing to exploit the distinction in cost drivers to achieve a better balance in the selection-incentive risk mix. We devise source contest strategies for such scenarios where special incentives can improve cost controls without proportionate rise in selection risks (Nalebuff and Stiglitz 1983).[4] We discuss two strategies where the buyer uses a dual source contest in the design phase, with either single sourcing to follow in the production phase or with dual sourcing to follow (dual source strategies have been studied by Anton and Yao 1992, 1989; Klotz and Chatterjee 1995; Riordan and Sappington 1989; Seshadri 1995, among others).

18.2 Design and innovation

A design phase often precedes production contracts. Suppliers involved with continuous improvement programs (CIP) and early supplier involvement (ESI) build in design expertise to their competitive advantages. The ability of a buyer to motivate better design from suppliers to what is done in-house is a key reason to outsource. One objective of better design is to reduce costs of production items. Suppliers affect production costs with designs that lower costs of their inputs, which may be direct production costs for the buyer. One popular measure of

success of a design phase is therefore a lower cost component or sub-assembly that meets or exceeds specifications. Sometimes firms specialize in sourcing designs and classify themselves as OEDs (original equipment designers). The OED is invariably allied with the original equipment manufacturer (OEM).[5]

A typical decoupled design and production phased award is as follows (Riordan and Sappington 1989).[6] During the design phase, an OED buyer awards a design contract for equivalent specifications for a fixed number, or a prototype, of an item under development to each of two suppliers, and each is called a half-unit contract. This is a purely cost reimbursement type of award as design costs are yet unknown, design is itself a moving target, specification may change, and engineering is risky. Once the design phase is over everyone gets to learn each supplier's design cost, and each supplier's design itself is evaluated for performance and production costs estimated.

The OED compensates its two suppliers for design acquisition costs, and sourcing moves to the next phase. Notice there is no separate incentive fee for the design phase. All the incentive comes from production phase profits. In our strategy, the allied OEM buyer awards the production contract. If sourcing is internal to an agency or company then Buyer E switches its OED cap for an OEM cap. This phase is not usually competitively bid as the design is available with the winning supplier. The production design is the winning design based on the previously known criteria, usually on the combination of performance and cost. The production contract may be single source or dual source, and the award may be fixed price, cost plus fixed fee, or cost plus incentive fee, as now everyone has a target cost from the design phase for each supplier. The buyer may source both designs or pick the single best product to source, and source different quantities of the chosen design from each supplier. Whatever the type of production contract, the supplier has an estimate of the net present value of profits from planned production. This provides the incentive fee for the purely cost reimbursement design phase for which there is no direct profit. In the sequel we will concentrate on the design phase sourcing strategy while incorporating the influence of various forms of production phase payoffs.

Strategy Query #37 – *Why does sourcing of design-and-production need special strategies?*

Design contracts with cost reimbursement have severe problems of verifiability of design effort and joint cost allocation. Effort in design is unobservable and ability of suppliers to influence costs despite best efforts is uncertain. Rarely can the supplier or buyer target an absolute level of cost. Often, the best a buyer can envisage is a cost lower than some benchmark or better than what some other supplier may promise. This is a relative target for design costs. Joint cost allocation is endemic as design elements are easily reused. Overhead costs in spot market business can justifiably be allocated wherever the design element happens to be used. A usual financial reporting practice is to write off design and development costs in the financial year, and this means that sourcing

business concluded and billed during the year may get more than its share of these costs, although benefits may accrue to projects in subsequent years.

The eventual success of design may have enormous impact on the buyer's future business once in its production phase. How can the buyer contractually pass on some of this future value to the supplier to motivate better effort at the design phase? Any viable method will need to be independent of a target production cost as this is usually nonexistent. Moreover, it should be able to accommodate insurance needs of risk averse suppliers in a highly risky activity with unobservable design effort costs, or unobservable opportunity costs that affect joint cost allocations.

18.3 Relative compensation

A strategy to overcome limitations of the LIC for the design contract phase lies in relative performance measures. The advantage of relative compensation is that such schemes remove the need to pre-specify target costs, and improve on cost control incentives without necessarily adding to insurance rents.

Strategy Query #38 – *Why use relative compensation?*

Relative performance stems naturally from a bonus such as a winner's purse, or from a shares of subsequent business competition. The chief advantage of relative compensation is that it removes risk associated with marginal product based rewards, yet provides incentive for effort through differential rewards for performance. The absolute level of cost realized is no longer so important to the magnitude of reward; emphasis is shifted to a yardstick on cost.

Relative compensation is especially important in the presence of multi-market joint cost allocations that may increase common costs in sourcing. Buyer E uses relative performance to reward effort at controlling allocated joint costs under cost reimbursement contracts. Buyers typically do not know supplier opportunity costs, and there is a tendency for all suppliers to take decisions that escalate these when input prices are subsidized with allocated joint cost sharing (as discussed in Cohen and Loeb 1990). Rewards from relative performance serve to reduce incentive by comparisons of such allocations across dual sources.

While the buyer can make cost control incentive arbitrarily large, the risk burden for suppliers remains lower than with corresponding incentives with fixed price contracts. This insight arises logically from how relative compensation makes *incentives independent of marginal product.* This means that compensation is not dependent on the rate of change of costs relative to a fixed and predetermined price anymore, but on other measures. What other measures are useful for relative compensation? The possibilities are (a) an index that benchmarks commodity prices that drive common costs; and (b) a rival's performance level that provides a benchmark for yardstick competitions.

Indexed pricing: A variation on fixed price contracts is the indexed contract. This form of contract does help with cost uncertainty but does not have any

additional value for design effort incentives. The buyer gains some benefit from distinguishing common and specific cost uncertainty (Goldberg 1985). The buyer or supplier first analyzes common costs across suppliers to determine the specific commodity component. Then they track a standard index for the commodity price benchmarked for a base year. Common commodity cost increases as measured by this benchmark are passed through with pre-specified index formulae.

Indexed Prices

Commodity costs are common to many suppliers, and are tied to an index that is updated periodically. For instance, the cost of fuel or steel is indexed to a base year at 100, and the index is updated every quarter by national statistical agency. The common price increase is carried through in indexed prices. The cost is say 80% of price, and an increment in the index is noted over the initial time of the offer. An example of an increment to price is: 80% * Price * change in commodity index.

Services are available, such as Purchasing Index Ltd (UK) that provide standard basket of typical purchases average price indexes over time.

Yardstick competitions: The limitation of indexed pricing arises from the necessity for buyers not only to know common cost drivers but also have a universally acceptable measure of their change. This is difficult for joint costs scenarios. In short, in order to make profit independent of marginal product index prices still require acceptable estimates of how much prices should be bumped up for input cost increases.

In the absence of this ability to classify all relevant common costs and index their rates, the buyer must take recourse to a comparative system of common cost benchmarking. The yardstick contract provides this alternative. A supplier is compared to another competing supplier on their observed common costs. The buyer reimburses costs and provides a prize or bonus to the better performing supplier, rather than using a price to determine the supplier profit. Here again the supplier's profit is independent of marginal product. Therefore, Buyer E can make the incentive to control cost as large as necessary by adjusting the prize to dissuade tendencies for egregious joint cost allocation.

18.4 Dual source selection risk

Buyer E uses a bidding competition to select the required number of suppliers for the complete design requirement. Let us call the complete design requirement the unit contract. The unit contract is the cost reimbursement type, so suppliers make no profit and no loss from this phase. Bids are for an expected profit from the production phase of the contract. Each supplier bids for a net present value of expected profit level from the production phase that compensates it for its design

phase opportunity costs. For equal split dual sourcing the portion of the unit design contract is a half, and the NPV of expected production profit is smaller for each supplier than the single source case. Buyer E needs three or more bidders for dual sourcing to be strategic. If there are less than three bidders, competitive dual source bidding has failed and Buyer E sets the fee at some reserve level and selects non-strategic suppliers, as discussed in Chapter 13.

Sealed bids, which are expressed in monetary amounts, are submitted simultaneously and Buyer E evaluates bids in private. Once all bids are evaluated in terms of monetary equivalents of all commercial terms, prices, and financial implications, the two lowest bids are selected. Let's say the winners are Supplier E and Supplier F. Other bidders leave for their alternate non-sourcing business opportunities. Our strategy reimburses both Suppliers E and F their audited design costs on conclusion of the design phase and awards either one or both of them a production contract.

A reasonable question to ask is whether Buyer E should employ the uniform second price (Vickrey) reverse auction as above, or whether the open cry discriminatory first- or second-price (totem-pole) reverse auction is preferable. As follows from our discussion in §17.9 in the risk averse bidder situation, the Vickrey reverse auction will result in the lower expected payment. Recall this is so since non-revelation to other bidders of sealed bids means bidders cannot reduce uncertainty and must bid more aggressively. Therefore, for awards discussed in this chapter, Buyer E is best served to use the sealed bid version of the uniform second price (lowest rejected bid) award discussed in Chapter 7.

Award's expected monetary profit: The supplier makes an expected profit from the expected production phase profit fee based on the award price. Given the supplier's risk aversion, bidding is best interpreted as bid utilities corresponding to certainty equivalent monetary profits. What utility fee to bid? A straightforward and intuitive interpretation is that vendors bid their opportunity fee when the buyer prices the award at its opportunity fee. The vendor's opportunity cost is its spot market utility alternative to the fraction of the design contract it gets – unit for the single source and half-unit for the dual source. The buyer's opportunity cost is the "second price": the profit fee from the production contract that corresponds to the lowest rejected vendor bid – the second bid for the single source, and the third bid for the dual source.

Strategy Query #39 *– How is the dual source award price different from the LIC award price?*

Award price differs for award types on the following counts is:

a. For a single source design-cum-production LIC, the target price is the award price that corresponds to the second lowest vendor's unit design-cum-production opportunity utility. The corresponding price incorporates information rents and overall contract profits.

b. For a dual source design with sole source production contract, a uniform second half-unit contract award price corresponds to the third lowest half-unit design contract opportunity utility. The corresponding price includes a margin

due to information rents and future winner's purse from sole source production profits.

c. For a dual source design and dual source production contract, a uniform second half-unit contract award price corresponds to the third lowest half-unit opportunity utility. The corresponding price includes a margin due to information rents and an expectation of the future share of production profits.

Knowing this, the buyer can determine the first component (information rent adjusted opportunity cost) of selection risk in our strategy (see also §17.6). This component, the award's expected monetary profit, is clearly higher for the dual source than for the LIC, as the third lowest bid corresponds to the award price for the dual source, while it is the second lowest bid for the single source.

If there were economies of scale, then the half-unit contract ties up disproportionately more resources of Supplier E or F than the unit contract. Opportunity cost driven joint cost allocation is therefore higher. This would contribute to a higher selection risk component. However, the sourcing could tie up scarce capacity as Chapter 14 discusses, leading to diseconomies of scale. The production phase expected profit from either a sole source winner's purse or a dual source share of future business award adds to expected monetary profit.

The remaining fee components are directly related to incentive risk. For the cost reimbursement design contest the buyer bears the entire design cost, and therefore all effort-adjusted cost is part of incentive risk. The remaining two components of selection risk fee are vendor's cost of effort and risk premium. These also affect incentive risk, as is evident from Exhibit 17.2.

We now examine two distinct award strategies for incentives using dual source cost plus awards. The differences stem from incentive risks for the winner's purse versus the share of business awards.

18.5 Winner's purse incentive risk

In this strategy, the OED uses a dual source for design sourcing but the OEM will use a sole source for production. The winner's purse award proceeds as follows. Of several potential Supplier Es and Supplier Fs, say a known number of suppliers participate in a bidding competition knowing it is a dual source design and sole source production program. Each bid is determined by the supplier's required utility from the design phase and discounted utility from the production phase. The buyer selects the two lowest qualified bidders as suppliers, and informs them of the third lowest bid from the contract. Common knowledge is also size of the additional purse, i.e., production contract derived profit fee that the buyer will award to the vendor, say Supplier E, who wins the design phase contract with the best performance-cost design. This is the so-called "winner's purse." Together with the winner's purse, the supplier's bid profit fee from the design plus production contract guarantees its entry as it exceeds the opportunity cost. With these sourcing rules, participants can determine their equilibrium

bidding strategy and contractual effort decision; and Buyer E can determine its optimal choice for the winner's purse.

The contest introduces a form of relative compensation. While both Supplier E and Supplier F get their costs for the design phase fully reimbursed and make a profit on the information rent adjusted opportunity cost as well, the winner of the design phase gets a purse from a production phase follow up contract over the higher design cost vendor. The purse amount provides the incentive for cost control, which can be as high as necessary to prevent unjustified joint cost allocation. Supplier E and F optimize with their choices of cost control measures, and the contract cost is therefore reduced by these incentives for cost control.

Strategy Query #40 – *How effective is the dual source contest for a "winner's purse"?*

While additional effort and lower joint cost allocations increases the probability of winning the purse, Supplier E for example faces higher disutility of effort. Disutility stems from the fact that Supplier E cannot subsidize its input costs to the full extent. Buyer E is charged less of potentially allocable joint design costs, more of Supplier E's managerial time is spent on reducing legitimate common design costs which Buyer E would have reimbursed. Moreover, Supplier F's similar effort cancels out net gains from such effort to Supplier E, and the effort dividend is eroded.

A measure of the reward comes from the production contract utility differential between winning and losing A measure of incentive risk is the rate of expected utility improvement with effort. Buyer E gets the optimal effort from its suppliers when marginal disutility of cost control balances expected utility of the rewards for cost control. The latter (i.e., the incentive) is the expected utility gain from winning the production contract derived prize. The expectation, of course, is over the probability of winning the design phase contest.

Clearly, the risk-reward level is higher as the purse increases. A key implication of the relative compensation method evident for the design phase is that effort and payoff are independent of marginal costs. Higher common design cost variances will not affect risks of winning, and supplier revenue on the risk insurance count can therefore be smaller. Recall that Supplier E's required expected revenue is increased by the cost of design effort and risk insurance. In our strategy, the winner's purse determines risk premium and therefore supplier effort and, in turn, the revenue.

The optimal cost-benefit tradeoff between subsequent production phase prize and efforts of common design cost-containment is given by (a) the benefit of marginal effort on common cost control less costs of this effort; plus (b) the effect of marginal effort on private cost control less cost of this effort; which should balance (c) the increase in insurance cost due to risk introduced by the contest for the prize. The optimal prize is that which balances these cost-benefit effects to minimize acquisition cost.

The design phase on its conclusion provides an estimate of the production phase cost. Better allocation and common cost policies give the winner of the

design phase not only the lower production cost estimate, but also the more accurate one due to a protracted design phase. This removes the likelihood of a winner's curse from mis-estimation of common costs. The *winner's curse-winner's purse tradeoff* is the lowered chance of a wrong estimate by the winning supplier from a high stakes design phase.

18.6 Share of business incentive risk

The buyer has the option of dual source in the production phase as well. Therefore, a second strategy, sometimes with preferable risk properties, is the dual source design contest when each of two selected suppliers from a bidding contest will develop substitute products to identical specifications under a design and development contract; and they both subsequently supply their products under future production contracts. The difference from the sole sourced winner's purse is that Buyer E dual sources the production phase as well.

Buyer E continues to use the cost-reimbursement contract with no direct profit fee throughout the design phase. Recall that the cost reimbursement contract is common when product development uncertainties are present (Hiller and Tollison 1978).[7] Each of Supplier E's and Supplier F's incentive fees is determined by the outcome of the design contest for a share of subsequent production business profit. There is a winner and a loser in the design phase based on the performance-cost criterion achieved for successfully developed products. The winner gets the higher share, and the loser the smaller share of the next phase's planned production business. The cost reimbursement contest allows the vendor to shift the entire burden of risk arising from uncertain design and development onto Buyer E, and should suit it best on that account. However, the larger profit fee from business to follow goes to the lower design cost supplier. The net present value of the total of the winner and loser fees is the "pooled" incentive fee or NPV of production business profit available as incentive for the contest (Schill 1985; Anton and Yao 1992; Seshadri 1995).[8]

Notice some important strategic features. Vendors bid for an expected half-unit design-cum-production contract profit fee. The pooled fee is twice the bid for the half-unit contract. It corresponds to the required net present value (NPV) of guaranteed profits of unit contract design plus production phases. This is determined for the award as the outcome of the bidding process, and it sets Buyer E's reserve bid-utility (an information rent adjusted opportunity cost, to be exact). For our incentive compatible bid mechanism, Buyer Es' reserve price is double the lowest rejected bid. In the two suppliers case this happens to be double the third lowest bid.

Buyer E faces several questions when designing this cost-plus contest. How to set the pooled incentive fee? How much risk to introduce via the winner's share of this pooled fee? What cost control effort will ensue? What role does Supplier

E's alternative spot market business play? The answers come from understanding interplay of incentive and selection risk in innovation.

Strategy Query #41 – *Should the buyer de-link design and production contracts?*

Incentives and innovation: In open sourcing, where there is no tie-in with a production contract, the buyer is free to award production contracts to another supplier independent of who does design contracts. When there is free market entry for the production business the firm can have incentive problems in design innovation. Any economic gains from innovative activity that may apply to the production phase is competed away by new entrants into the business. Why then should firms innovate for sourcing business? The contract for innovation itself will not motivate a potential supplier since the buyer cannot directly compensate innovation effort that it cannot observe. Nor can the buyer credibly appeal to the prize from the production phase in open sourcing due to competitive entry of other suppliers.

In tied-in or partially coupled sourcing as opposed to open sourcing, the production contract is restricted to one or more of the design developing firms. Then one possibility is that a reward could come from the stock market gains of the firm that wins the design contest due to the tied-in production business (Rogerson 1989).[9] In order that the buyer commit to the reward to the innovating firm in such a joint innovation - production project, the share of production business for a winner and a loser must be public knowledge at the start, prior to effort in the design contest. Defense analysts suggest that contests during design and development stages result in superior sourcing outcomes to contests during routine production because it rewards lower cost and higher reliability designs. Indirect empirical evidence on government sourcing programs indicates that full - scale development (FSD) and production phases, where cost containment is based on a contest, showed lowered average cost growth (Mayer 1987).[10]

Strategy Query #42 – *How effective is the dual source share of business contract?*

Let us briefly examine a selection risk component that changes here. How does the buyer set the award's monetary profit? Buyer E has several ways to set the pooled profit fee given the bid information. We argued that an optimal mechanism is the lowest rejected uniform price award, and this sets the pooled award fee at twice the third lowest bid for dual sourcing. Pooled fee having been set, the two selected suppliers engage in the design phase and deliver comparable design work, corresponding to half the unit contract each. The unit contract is twice each supplier's work quantity since this is a dual sourcing situation. The actual costs are audited and reimbursed by Buyer E. The audit process determines the higher and lower cost suppliers, and therefore the winner and loser of the cost-containment contest. The winner is the supplier who delivers the best design at the lowest design cost. The pooled fee times the winner's fraction is the payoff for the selected vendor who outperforms all others. The pooled fee times the loser's fraction is the payoff to the selected vendor who comes in second-best.

This highlights that the production fee is different for the two suppliers, unlike the winner's purse. Instead of a fixed prize going to a single winner and nothing to the loser, the pooled fee from future business is split in the shares among the two contestants. The larger portion goes to the low cost supplier. The previous strategic analysis in §18.5 carries through with some small differences. This share of business was declared at the start of sourcing, and Buyer E has no reason to depart from this fee division. The design phase actual costs have been paid for work already delivered, and the same total profit fee has to be paid whatever way it is apportioned. The profit fee fraction (greater than half) that goes to the winner is independent of actual costs; the winner's fraction or portion and the loser's portion is known and can be committed to at the start of the sourcing process (Riordan and Sappington 1989; Seshadri 1995).[11] If there is a chance Buyer E may not pay at all, the pooled fee should be put in escrow; but actually this problem of Buyer E commitment to fees is possible independent of contests, and exists for any contract.

Supplier E optimizes with its choice of effort. Additional effort improves the probability of winning, since it reduces contract cost. On the downside is disutility of effort and the equilibrium result that the other supplier also increases effort to cancel out any advantage. A measure of the reward comes from the utility differential between winning and losing; and a measure of incentive risk is the gradient of utility with effort. Therefore, Buyer E can conveniently assess the relative incentive risk-reward.

In this strategy as well, relative compensation makes risk-reward tradeoffs independent of actual design contract cost. It is evident that design effort depends on the share of business, and not on uncertain design costs. As a consequence, Buyer E's can manage its design acquisition cost by controlling the effort cost balance with selection insurance costs, by appropriate choice of share of business and pooled fees, whatever the production cost.

Buyer E's overall expected acquisition cost for design and production phases in the share of business contest is the sum of both suppliers' design and production costs and revenues. Revenues include fees for risk premiums and effort costs as well as surplus required for participation and selection information rents. Each vendor's bid includes expected information rent adjusted opportunity cost and this required revenue, and the production cost when that phase is completed.

The three terms in each seller's revenue corresponding to selection risk are the award's expected monetary profit, effort cost and insurance cost, respectively (as in §17.6). Since dual source splits the unit contract, we should use expected alternate utility for the third lowest bid. With these strategic insights Buyer E can determine optimal design of the share of business award.

Optimal strategy: Buyer E seeks the optimal incentive risk-reward tradeoff that minimizes acquisition cost. In our strategy it balances risks from the design contest with rewards from share of production business contracts. The strategy

will optimize (a) the fraction for Buyer E to award the winner of the contest; (b) the corresponding fee bid by suppliers; and (c) cost control effort by suppliers.

18.7 Risk-return tradeoff under common and private cost

To complete the comparison with Chapter 17's LIC we must ask: What is the effect of halving the unit design contract? What is the effect of halving the expected production contract profits? Risks are split and payoffs are split, but not exactly by half. Even though contract size is halved for each supplier under dual sourcing, usually the scale effect and utility curve effect are such that the certainty equivalent monetary profit is either more or less than half that for the single source. In addition the information rents are higher for both winner's purse and share of business due to the order statistic of the expected award price. For the dual source the order statistics corresponding to the third lowest bidder provides the award price. For the single source the order statistics corresponding to the second lowest bidder provides the award price. The support for the spot market utility distributions is also compressed for half the unit contract, but again there are likely scale effects.

The likely net effect is increase in dual source award's monetary expected profit. Net selection risk fees across both vendors would likely exceed corresponding components for the single source award. Buyer E can now assess the overall advantage of making risk independent of marginal (specific and common) cost estimates, while reintroducing risk in the form of a contest. Its expected acquisition cost for the contest is total adjusted design cost for the two suppliers increased by costs of effort in design and production, risk premium and required surplus fees. Perhaps the most significant advantage is a target cost can be arrived at after a design phase, rather than as fixed estimate as with a LIC.

18.7 Conclusions

Our chief concern in this chapter was how design performance and selection risks and incentives interactively affect sourcing strategy when suppliers can expend costly effort at innovation. As usual, suppliers aim to balance risks from such design programs with returns from production contracts. They do so by building in various rents. Our discussion integrates cost structures to include opportunity costs in selection risk and performance costs in incentive risks that have both common or joint values, and private or specific values. When risks are very high, as when design cost estimation errors are likely to be high, insurance margins or risk premiums tend to be prohibitively high for the usual fixed price or even the popular incentive contract. One way around this problem is to employ a design cost reimbursement contract that transfers all risk to the buyer. An ensuing problem is that of providing adequate incentives for design effort for cost

mitigation. This problem is compounded when joint costs and design estimation bias are present, since suppliers have little incentive to avoid cost inflation. Thus the cost reimbursement contract or even a high sharing rate incentive contract has very poor design incentive effects. To deal with this problem, the buyer must look beyond single source contracts.

A more efficient match between the risk-reward tradeoffs for the buyer and dual suppliers in these scenarios can be reached with dual sourcing and relative compensation. Risks of selection, and risk from a subsequent contest between successful suppliers provide suppliers with incentives to allocate joint costs better to establish competitive price points, and expend more effort on cost controls. Better incentives for allocation of costs without concomitant risk premiums are a major advantage. We can identify separable components and compare the risk-incentive tradeoffs from the three distinct award types: incentive contracts, winner's purse and share of business. The chapter illustrates that the efficiency of business-to-business transactions depends to a large degree on the ability to match multi-stage risk-reward tradeoffs between suppliers and buyers.

This chapter focused on the sourcing of design, development and production services. These scenarios are gaining importance with the trend towards BPO (business process outsourcing) in the private enterprise system. However, they have existed for a long time in public goods sourcing. Increased strategic risks faced by buyers and suppliers in this context required special approaches to match risks of selection and production with cost control incentives (Macbeth 1987).[12] Implementation of advanced manufacturing technologies and just-in-time (JIT) production techniques will bring about an integration of the sequence of events leading up to supplier selection with the supplier's continuing performance under changing performance requirements.

18.8 Strategy Query Checklist

The strategic queries raised and answered here are:

- *#37 – Why does sourcing of design-and-engineering need special strategies?*
- *#38 – Why use relative compensation?*
- *#39 – How is the dual source award price different from the LIC award price?*
- *#40 – How effective is the dual source contest for a "winner's purse"?*
- *#41 – Should the buyer de-link design and production contracts?*
- *#42 – How effective is the dual source share of business contract?*

18.9 Proxsys®: Incentive Fee: Yardstick Contracts

Your program from the last scenario of Chapter 17 allows other design options. This scenario allows you to design dual source risk sharing contracts: the winner's purse and the share of business contract. Exhibit 18.1 shows the relevant screen.

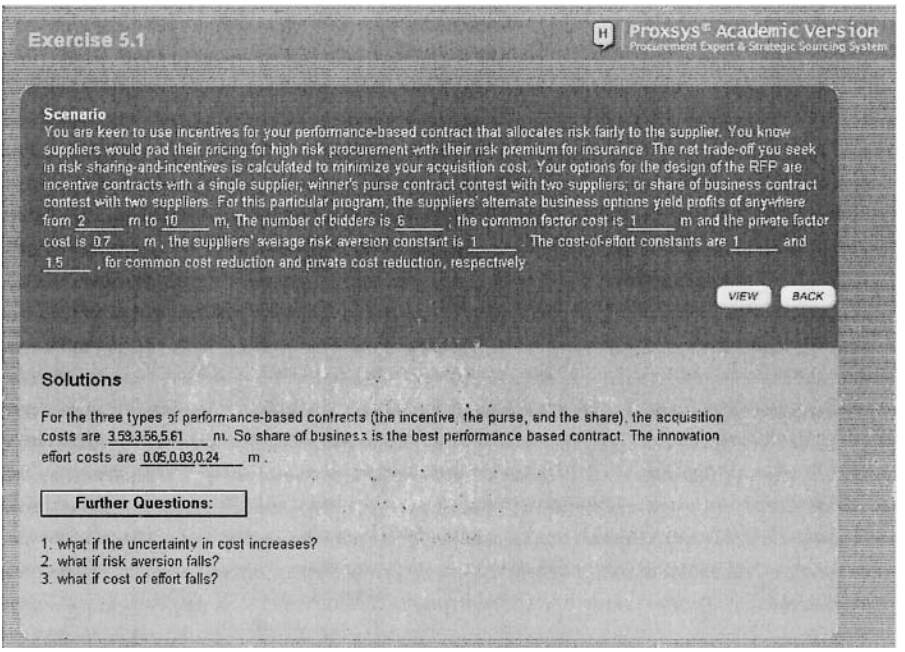


Exhibit 18.1: Exercise 5.1 on Incentive Fee Contracts. Data is picked up from the environment index, but you can make changes. The LIC, the Winner's Purse and the Share of Business contracts can be readily compared for cost and innovation effort.

Exercise 7: You are keen to ask *Further Questions*. You know suppliers would pad their pricing for high risk sourcing with their risk premium for insurance. The net trade-off you seek in risk sharing-and-incentives is calculated to minimize your acquisition cost. Your options for design of the RFP are incentive contracts with a single supplier; winner's purse contract contest with two suppliers; or share of business contract contest with two suppliers.

For this particular program, suppliers' alternate business options yield profits of anywhere from 2 m to 10 m; The number of bidders is 6; the common factor cost is 1.0 m and the private factor cost is 0.7 m ; suppliers' average risk aversion constant is 1. Cost-of-effort constants are 1.0 and 1.5, for common cost reduction and private cost reduction, respectively.

Exhibit 18.2 shows the comparisons between the incentive fee based contracts.



Exhibit 18.2: Incentive Fee Contracts: Comparison. Detailed comparison among the three incentive fee contracts along several key dimensions shows tradeoffs among various sourcing objectives.

Exercise 8: This is a deeper look at the previous scenario. The award you have chosen is the Incentive Contract. You wish to know the supplier's profit expectation and the sensitivity to sharing rate in particular. Exhibit 18.3 illustrates.

Further questions: Further reports for several questions are available. For instance: What if uncertainty in cost increases? What if risk aversion falls? What if cost of effort falls? How does the supplier's profit decrease with sharing rate? How does the acquisition cost decrease with risk aversion?

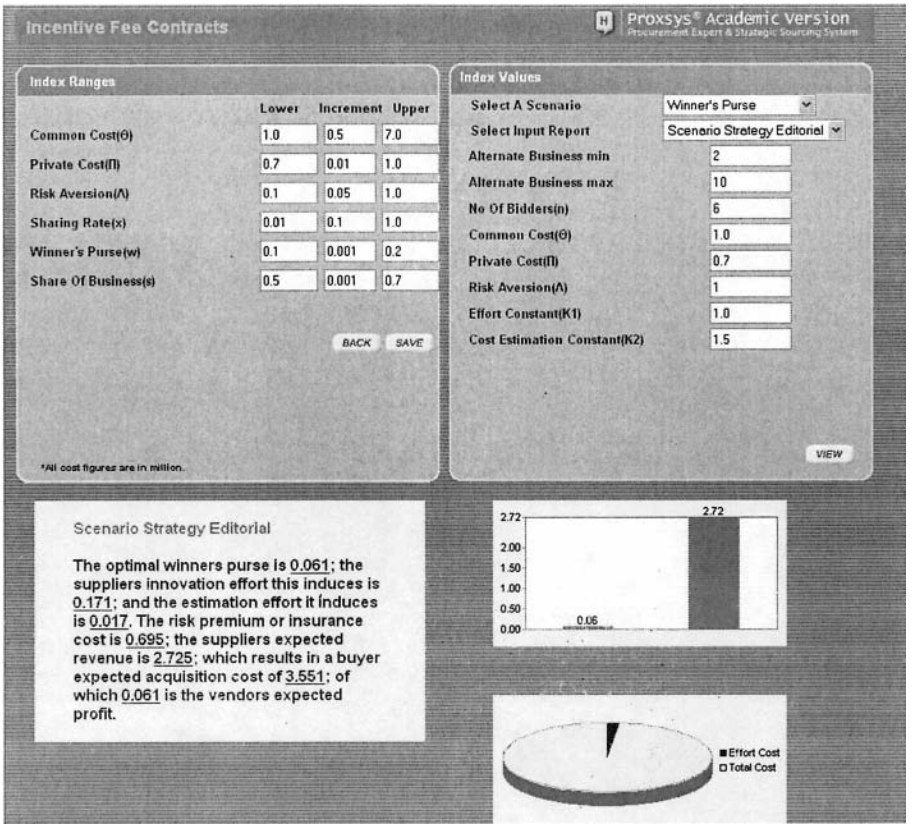


Exhibit 18.3: Incentive Fee Contracts: Winner's Purse. The strategy editorial is supplemented with bar charts on the prize amount, the acquisition cost. The pie chart shows the proportion of effort to total acquisition cost.

Exercise 9: This is a deeper look at the previous scenario. You have chosen the winner's purse contract and so will select two suppliers, one of whom will get a purse for better cost performance. You must decide on the purse, and determine how acquisition cost would change when some of the parameters are altered.

Further questions: What is the change in acquisition cost when risk aversion rises? How does the required purse change? What is the implication of reducing or increasing the purse? How does common cost uncertainty influence the results? Exhibit 18.4 illustrates.

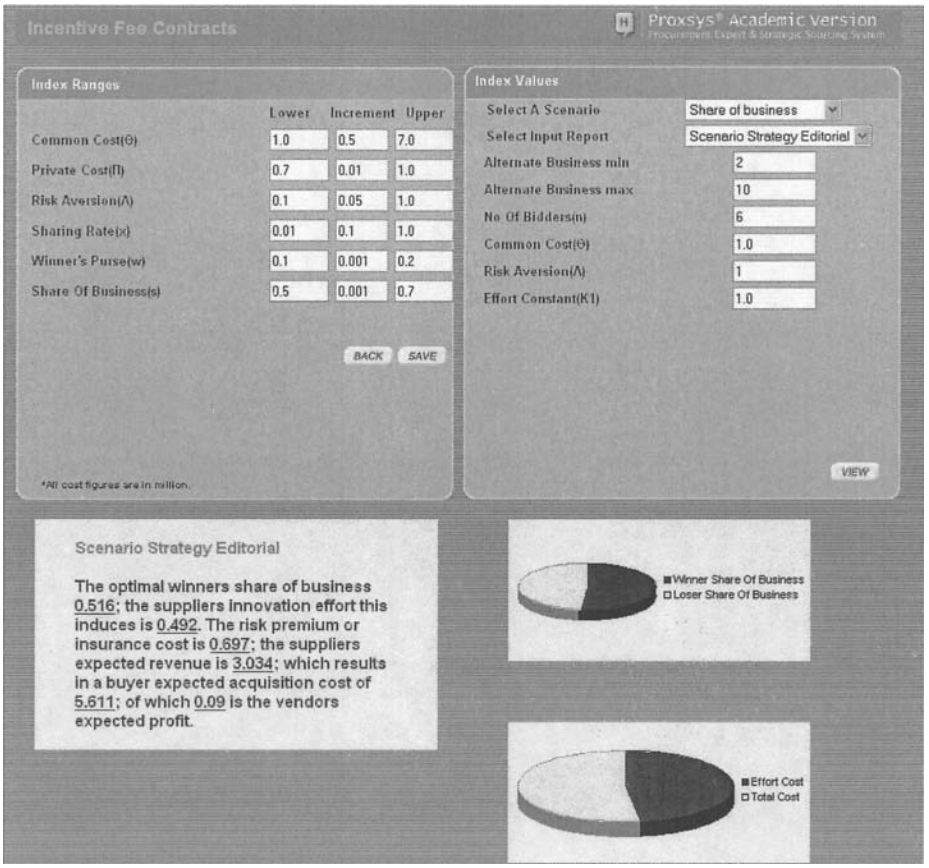


Exhibit 18.4: Incentive Fee Contracts: Share of Business. The strategy editorial is supplemented with a pie chart on the winner's and loser's share. A second pie chart shows the proportion of effort to total cost. Compare this with corresponding proportions for the Winners' Purse and LIC in Exhibits 18.3 and 17.3, respectively.

Exercise 10: This is a deeper look at the previous scenario. You have chosen the share of business award. You can vary the share each supplier gets in orders placed over time by alternating, or simultaneously for a single one-shot sourcing. You need to decide what shares to allocate among the two suppliers.

Further questions: What will change when share is increased to 0.6? How does the cost uncertainty influence the results? What is the impact of risk aversion?

Notes

Chapter 1

[1] *Procurement In the Decade Ahead*, A.T. Kearney (2000). The consulting firm is one of many who have white papers on procurement and sourcing.
[2] In the absence of inflation indexing, many contractors at the start of the twentieth century eventually went bankrupt leading to nationalization of their concessionaire contracts.
[3] The inverse relation between management workload and risk is the risk-benefit tradeoff for management in a Gartner Consulting Group's white paper by DaRold, Grigg and Berg (2002).
[4] The Chief Purchasing Officer (CPO) position (according to McKinsey) is advertised as $300,000 compensation; as responsible for direct reports to directors of strategic alliances; and responsible for analysis, performance measurement and key commodities.

Chapter 2

[1] Argyres (1996) provides a discussion of capability and transaction cost arguments for make-or-buy decisions.
[2] Seshadri (2003) provides the internal and external agency tradeoff explanation for dual-distribution in franchising.
[3] Such as Staples or Office Depot.
[4] The demand for imports has often been modeled as a log-linear function, where imports are inputs to the production technology.
[5] Both these assumptions are also justified in the cited literature [i.bid. p. 505].
[6] The analysis is available online as an unpublished working paper *An outsourcing dilemma: When to say "when"?* at http://www.acquinas.com/Papers/
and also examines cross border outsourcing elasticities with GDP.
[7] De Fontenay and Gans (2004) raise this interesting issue of outsourcing as a decision to divest.
[8] The paper discusses the historical role of governance forms in risk buffering and throughput capacity.
[9] They show that these are the two main deterrents to outsourcing. They have interactive effects with production efficiencies that increase their deterrence effects on outsourcing even more.
[10] Grossman and Helpman (2001) use a general equilibrium framework to derive the degree of outsourcing.
[11] Furst and Melumad (1999) derive the propositions showing equilibrium outsourcing among competitors even when cost functions are symmetric. Gupta and Seshadri (1994) discusses synergies among competing agents that lead to horizontal resource sharing.
[12] This leads to a possible slogan of "Do thy best, outsource the rest. When synergy be thy quest, partly source even thy best."
[13] Such as XML and platforms like BizTalk™ from Microsoft®.
[14] Liu (1999); Presutti (1992); Pan *et al* (1991); Ramasesh *et al* (1991); Hanson and Wilson (1990); Rogerson (1989);Treleven and Schweikhart (1988); Mayer (1987); among others.
[15] There has been some criticism for an under-emphasis of multiagency situations in the early development of principal-agent theory.

[16] Among other reasons, these include learning specificity in Lee (2000), and Deng and Elmaghraby (2002); diseconomies of scale in and Hazra, Mahadevan and Seshadri (2004), Lee (2000); vertical risk sharing in Seshadri (1994; 1995); common costs, moral hazard and horizontal risk sharing in Seshadri (1995); demand volatility in Seshadri, Chatterjee and Lilien (1991); and Hazra, Mahadevan and Seshadri (2004); and entry of additional bidders Bulow and Klemperer (1996).
[17] The paper discusses analytical methods to demonstrate the primacy of competitive intensity.
[18] This problem is widespread in government as well as industry procurement.
[19] Tirole (1988), p.27 discusses the industry phenomenon of rotation among suppliers.
[20] Basu (1996) indicates that decreasing returns to scale may result from marginal cost increases that more than balances fixed costs.
[21] Rogerson (1992) provides an analysis of the accounting incentives for wasteful supplier behaviors
[22] Gupta and Seshadri (1994) model a similar multi-agent situation among SBU managers with differentiated output but horizontally shared resources internal to the firm.
[23] Itoh (1991) provides sufficient conditions for compensation based on teams rather than differentiated outputs to be optimal.
[24] McAfee and McMillan (1991) show this by adding an adverse selection component to Holmstrom's (1982) analysis of moral hazard in teams.
[25] Barron and Gjerde (1997) consider peer pressure in the Principal-agent architecture with agent imposed standards and imperfect signals of co-worker effort; Ali and Seshadri (1993) consider consumer imposed relative quality standards among competing firms, in a marketplace with downward sloping demand and imprecise consumer perceptions of quality.
[26] Ziv (2000) studies the optimal hierarchical structure, and this necessitates a multi agent view of risk aversion, effort costs, monitoring costs and supervision.
[27] Elmaghraby (2000) reviews a variety of supply contract competitions including multiple sourcing approaches.
[28] A.T. Kearney (1999). Assessment on Excellence in Procurement.

Chapter 3

[1] Vernon L. Smith (1991) summarizes the value of standard models in predicting behavioral outcomes, and draws attention to decision costs and convergence rates as where some inadequacies may lie; and surmises that standard models of auctions and contracting survive because they coax Pareto optimal behavior from agents who do not know what it means.
[2] The adverse selection efficiency losses are not predicted by symmetric models; other differences arise when real bidders have heterogeneous risk aversions and asymmetric expectations, further increasing adverse selection efficiency losses, especially in cost-sharing contract bidding.
[3] For instance, the Carlucci Steering Committee identified six organizations in the US involved in defense procurement with distinct perspectives and interests.
[4] Bolton and Whinston (1993) for instance discuss vertical integration; Cachon and Lariviere (1999) discuss capacity allocation to multiple buyers.
[5] Vistnes (1994), for example, shows that regions of cost uncertainty and asymmetric information exist for whether the optimal contract with a monopoly risk neutral supplier is a fixed price or a partial cost reimbursement contract in Medicaid multi-period procurements.
[6] Lewis and Sappington (1997) show that it is preferable to split the procurement between a planning agent and a production agent in such circumstances.
[7] In a special case of pure insurance contracts, however, there is a duty to disclose all material facts that would affect the risk assumed by the insurer. Even if the significance of the fact is not realized by the insured, it must be disclosed for such insurance contracts not to be rescinded in case of damage claims.
[8] Laffont and Tirole (1990) show that in the presence of adverse selection a menu of renegotiable and long-term contracts may be better than either short-term or long-term contracts.

[9] Mishra (2001) develops an evaluation model for episodes and its impact on likelihood of relationship continuity. Wilson (1995) studies the variables that affect relationship quality.
[10] Benoit and Krishna (2000) develops the theory of punishment strategies and demonstrates Pareto superior equilibriums for the repeated Prisoner's Dilemma game.
[11] The argument is similar to the game-theoretic reasoning on punishment strategies in repeated games that players may use to threaten an inferior equilibrium for deviations from the Pareto superior outcome; for example in the repeated Prisoner's Dilemma game..
[12] Parsons (1989), for example, uses this fact for financial valuation of forward pricing contracts.
[13] This is a two-period strategic interaction, different from the usual one period analysis that trades off the principal's conflicting interests in extracting agents' information rents and providing cost control incentives.
[14] Laffont and Tirole (1987) derive the optimal linear contract. See Chapter 4 and 10 for a discussion.
[15] Chemdex maintains a register of 2,200 suppliers and more than 26,000 users of life sciences materials.
[16] FreeMarkets says that its customers have experienced savings of 7 to 10 percent for commodities and 7 to 25 percent for custom purchases.
[17] An exchange called e-Steel, which boasts more than 2,200 buyers and sellers, automates the transaction process and supplier relation-ships with buyers. Its order-tracking, inventory-management, and reordering processes routinely generate significant cost savings and allow buyers and sellers to reassess, respectively, their procurement departments and sales organizations.
[18] SiteStuff, for instance, is a property maintenance exchange that monitors materials, repair, and operations spending per building and compares these costs with those of average and best-run buildings of the same type and size. Neoforma.com singles out and profiles hospital medical departments with the best floor plans, equipment, and stock of materials

Chapter 4

[1] Trent and Monczka (2002) reveal several advantages derived from global sourcing summarized here.
[2] A variant of the conjoint method of deriving weights from utility rankings is the MAUT approach to selection of suppliers. Other methods are Analytic Hierarchy Process and Multi Objective Programs.
[3] In 1984 the US Congress passed legislation mandating competitive source selection for nearly all government contracts. DoD Appropriations Act (1984), PL 98-212
[4] The U.S. government procures from small businesses and must frequently provide work-in-progress payments to finance supply. Resource constraints have historically been circumvented by the US Department of Defense by policies that reduce the contractor's dependence on debt financing. This required progress payments coupled with profit management.
[5] The Defense Financial and Investment Review (DFAIR 1985; IV-6) offered a criticism:" Current progress payment rates used to compute the amount of Government payments to military contractors are too high, given present interest rates, the rate of inflation, and other factors used to justify increases in the rates...Reducing current progress payment rates to 80 percent for large businesses and 85 percent for small businesses would save the Government $250 million per year in interest costs, and reduce FY 1985 estimated cash outlays by approximately $2.1 billion."
[6] Gansler (1995) discusses the issue of defense industry conversion to commercial production. Rogerson (1988) notes the prevalence of dual-use production for government and commercial business by suppliers.
[7] Henderson (1998) argues that poverty alleviation could result from poverty and growth sensitive defense procurement conversion programs.
[8] Rogerson (1988) provides the theory ad evidence for this from defense procurement.
[9] Karpoff, Lee and Vendrzyk (1999) discuss the differential negative abnormal stock returns penalty for large and small suppliers when investigated, indicted, or suspended for fraud.

[10] Bower (1993) found that competition was of the highest value among various contracting measures.
[11] Reichelstein (1992) discusses the German DOD process, aimed at arriving at realistic cost estimates.
[12] Lewis and Sappington (1997) model incentive contracts where planning information is crucial. They show that the buyer would prefer to award the contact to two suppliers – one who does the planning and another who does the production.
[13] Harris and Townsend (1981) derive optimal pricing schemes and show the conditions when auctions are preferred.
[14] Deng and Elmaghraby (2002) derives optimal terms for parallel sourcing to lead into sole sourcing, and describes industry applications and examples of such hybrid sourcing.
[15] Seshadri (1988) reports on experiments aimed at uncovering relationships between reprocurement, awards types, and investment.
[16] They call for a workshop approach to determining the shared judgments in the Owner Contractor Work Structuring, for proper alignments.
[17] Gordon Moore of Intel® stated the Law, in effect that the density of transistors on a microchip in production doubles every eighteen months.
[18] McMillan, Whalley and Zhu (1989) shows that 78 percent of the Chinese agriculture productivity gains between (1978) and (1984) may be attributed mainly to incentive changes in the procurement process.

Chapter 5

[1] A Review of Public Procurement. Findings and Recommendations. Ministry of Finance and Personnel. Northern Ireland. (2001).Especially pp. 8-9; 31-32; 44-45.
[2] National Automated Accounting Research System has data on percentage of firm's revenue derived from government contracts.
[3] The examples of successes reported here of break out and F3 techniques comes from defense acquisition studies by the US Defense Acquisition Institute in the late 1980s. .
[4] Mennemeyer *et al* (1987) proposes a mechanism that awards capacity even to losing bidders, albeit at a lower price.
[5] The empirical study shows that an additional potential bidder raised the probability of dual sourcing by 12 %. The slope of learning curve is between 75-80% for missiles – meaning a doubling in cumulative production leads to cost saving of 20-15% in unit price. A doubling of per period production reduces the unit price by about 30 %. For the case of missiles, break even time is 5-7 years for dual sourcing — subsequent to this break even time dual sourcing is better. However, from a net present value viewpoint with a 3% discount rate, dual sourcing is uneconomical. The study calls for further empirical study based on economic theory, and better attention to account for selection bias, cost versus price data, inflation, and more sophisticated panel data.
[6] Defense Logistics Agency Statement, Senate Armed Services Committee, March (1999). Many useful statements of sourcing positions are available through the years from defense agencies in all the service corps.

Chapter 6

[1] Whether the offree relies and has some economic burden to bear is crucial. If there is no loss to the offeree there is no case for compensation.
[2] A distribution of percentages on the price points was obtained for each of pessimistic and optimistic and seven price types aggregated across four projects, as a weighted sum across types. Individual proposal price type distributions are similar to the overall distributions. This distribution was used in

a Monte Carlo simulation to give the simple total as the expected price, and presented as a cumulative probability of exceeding the cost, with a mean and standard deviation.

[3] DuPont's $4 billion contract with CSC and Arthur Anderson allows competitive bidding beyond the baseline contract for services. Other experiences have led to problems when the vendor refuses to continue services when the customer switches to a different hardware supplier.

[4] Cigna Healthcare of Atlanta settled with Entex Information Services for a one year contract, despite transaction specific investments. The costs of switching to a new supplier seemed to balance the costs of deferred recovery of investments. The contract has now been extended (ibid.)

[5] In the past, regulatory activity in US Government procurement led to moderation in the profits of contractors. The Cost Accounting Standards Board (CASB) was legislated for government procurement in (1970); and the Renegotiation Board (since 1950s) and Contract Board of Appeals in the 70s were established to monitor profits. CASB and RB were allowed to lapse by 1980, but had an impact on contractor profits.

[6] Note that this definition may in fact lead to negative amounts. Cohen and Loeb (1990) develop the understanding of opportunity costs and their impact on bidding for contracts. See also Chapter 8.

[7] In the cited study, the constrained optimization integer programming approach led to an optimal strategy of multi sourcing from four suppliers for a product group – ball bearings, a $1 m purchasing bill – in a steel company with about $1.4 b in annual purchasing. Single sourcing in this product group increased the cost by 13 percent. Total sales to the steel company constituted 74 % of the total cost of ownership in the current non-optimized regime. The re-jiggering due to optimization changed the mix of costs and the sales costs decreased by over 18 %, while the total cost of ownership decreased by over 11 % (due to non EDI suppliers with nevertheless better prices coming into the mix). The shares of business were 51.4 %; 35.1%; 11.7 %; 1.8%. Also, Richardson and Roumasset (1995) presents simulation studies that establish the preference of more than a single supplier.

Chapter 7

[1] The public savings in the Santa Monica Freeway reconstruction after the 1994 earthquake is estimated at half a billion dollars, due mainly to $200,000 a day damages or bonus on delays or under-runs.

[2] An appendix to the cited paper contains the Public Contract Code: Liquidated Delay Damages Act.

[3] Katz (1996) argues that asymmetric information allows the party to gain an advantage in bargaining; and should bear greater risk on that account.

[4] Lacity and Willcocks (1998); The paper also contains an interesting quote: "There is a lot of rubbish talked about partnerships. What are called "strategic partnerships" are easy when everything is going well. It's good if you can work together, but it's not a true partnership unless you have a joint financial venture. " (IS Director) Pg 387, MIS Quarterly/September 1998).

[5] Katz (1996) refers to federal law requirements on second sourcing in 10 USC §2304 (b) (1) 1994; and 41 USC §253 (b) (1) 1988.

[6] Feinman (2000) presents a summation and critique of Macneil's extensive writings on relational contracting, for instance, Macneil (1974, 1978, 1980, 2000). Contract law is distinguished from tort law, and from property law; but development within neoclassical law has created several sub-fields of contract law, and product liability law has roots in tort law (Feinman, ibid.). These developments are relevant to supply contract enforcement.

[7] Gartner group views SLAs as not simple contracts on service up-time reliability such as 99.9 percent, but as relational contracts tailored to specific customers.

Chapter 8

[1] The term RFQ often implies sole sourcing, while RFP implies competitive source selection. We will use RFQ here for both situations, unless otherwise stipulated.

[2] Puto, Patton and King (1985) report on field experiments that assess the extent of frame effects on buyer risk perceptions in vendor selection decisions.

[3] Fishner (1989); pp. 80-81 notes that B&P costs have increased dramatically since the 1950s. Firms that undertake R&D to corner government contracts have no guarantee of winning and vastly increase their risks.

[4] Estimating the strategic value of long term forward purchase contracts using auction models. *The Journal of Finance*, Vol 44, 4, 981-1010.

[5] Investment incentives in procurement auctions. Review of Economic Studies. 71, 1-18.

[6] Interestingly, King *et al* (1992) shows that the slope of the investment cost function is the symmetric private values distribution function; and therefore a quadratic investment cost in the homogenous scenario yields the uniform probability distribution as the private type distribution for subsequent scenarios. This book uses the uniform type distribution extensively for its software exercises.

[7] We see later that the use of a second price Vickrey auction method is attractive since (a) it is efficient (b) it is time consistent (c) it maximizes the seller's revenue. The VCG mechanism discussed in Chapter 9 and the second price auction are aligned.

[8] Most auction theory results are for single dimensions.

[9] They emphasize that in the construction sector about 40 percent of the projects in private sector where there is no policy on the matter is let though negotiations.

[10] A real dilemma is between complexity handling alliances and cost reducing transactions. GE buyers are making a sea change from working their relationships with interpersonal communication to web enables sourcing.

[11] This is sometimes referred to as third degree price discrimination, to distinguish it from quantity discounts (second degree price discrimination) and product versions (first degree price discrimination).

[12] See Paarsch (1992) for an empirical approach to identifying CV features in forestry, and Giliberto and Varaiya (1989) for mixed CV-IPV features in the banking industry. Hong and Shum (2002) find evidence for IPV, CV and affiliated value auctions in the construction industry.

[13] Capen, Clapp and Campbell (1971) describe this now notorious problem for common value auctions.

[14] See Milgrom and Weber (1982) for a summary of these results for CV, AV and IPV models, and their several cites for further details.

[15] Herein resides a key justification for the use of computational aids for arbitrary auction forms. Buyers should be particularly keen to demonstrate their ability to compute equilibrium bids!

[16] Harris, Milton and Raviv, Artur (1981). Allocation mechanisms and the design of auctions. *Econometrica*, 49, 1477-99.

[17] Rothkopf, Teisberg and Kahn (1990) argue that this might be a reason for rarity of sealed bid second price awards.

[18] For instance, under the discriminatory uniform price reverse auction the equilibrium bid or marginal cost is the expected kth lowest of the (n-1) remaining bids given that the supplier has privately learned its cost, and conditions its expectation on the kth lowest bid being less than this cost.

[19] Bulow and Roberts (1989) provide the interpretation that expected revenue from an auction equals the expected marginal revenue of the winning bidders.

[20] The information rent is the inverse hazard function, [F(v)/f(v)].

[21] McAfee and Mc Millan (1989) show the price discrimination rule for two classes of bidders: the advantaged and the disadvantaged. McAfee, R.P. and McMillan, J.(1989). Government procurement and international trade. Journal of International Economics, 26. pp. 291-308.

Chapter 9

[1] This approach is crucial for models of bidding competitions with risk averse vendors, and is discussed more fully in Chapters 17 and 18.
[2] See Chapter 14 for the implication of this principle in capacity constrained contracting with variable quantity.
[3] In most scenarios of Part 2 the basis for the selection auctions are therefore opportunity cost characteristics of suppliers.
[4] This statement paraphrases Krishna and Perry (2000); P. 11 Theorem 1 (Payment Maximization) for auctions.
[5] Hong and Shum (2002) warn against this confusion in empirical work where comparability of contracts is not established.
[6] McAfee and McMillan (1987) show that when an entry fee can be used, it is optimal to have no reserve price for the best auction, which is standard in all the other ways considered by Myerson (1981).
[7] This is a Nash equilibrium in the sense that when other sellers are known to be using this strategy, the seller has no reason to unilaterally deviate.
[8] The two outcome event is a Bernoulli trial, and the number of bidders itself therefore follows a Binomial distribution.
[9] Chapter 13 develops this sourcing scenario.
[10] Seshadri, Chatterjee and Lilien (1991) establish the conditions for the existence of an equilibrium between the number of bidders and entry into the competition.
[11] See Chapter 14 for designs relating to capacity reservation contracts.
[12] This is a popular result in the optimal auction literature and hinges upon the marginal expense curve [v+ F(v)/f(v)] being monotonically increasing in v. As the distribution of cost, v, is compressed the information rent profit falls and the ratio [F/f] falls and, as can be visualized in Exhibit 8.2, the marginal expense curve tilts down.
[13] Chapter 18 discusses a two stage design with such extremes.

Chapter 11

[1] The classic sources for the development of expected utility theory are these books, and the papers they cite.

Chapter 12

[1] The development of the general quantitative theory of principal and agents, known as Agency Theory with specific Principal-Agent Models (PAM), has been in several key papers and in some major reference books (see several articles by Grossman, Hart, Holmstrom, Laffont, and Tirole, among many others).
[2] Seshadri (1995) discusses this lack of attention, and argues for integrated selection and incentive risk in dual sourcing.
[3] Gates and Miller (1985) document the empirical regularity of price increases in US Government projects. See Chapter 5 for further discussion.

Chapter 13

[1] Bulow and Klemperer (1996) stresses the importance for buyers of attracting more bidders; and claim that resources are better spent in expanding the market than in collecting information for better mechanisms.

[2] The binary outcome event, like the toss of a coin, is called a Bernoulli trial.
[3] Greer and Liao (1986) used this term to reflect the critical effect of industry capacity utilization rates on the buyer's price.

Chapter 14

[1] Chapter 17 identifies a limitation that joint cost allocation imposes on linear incentive contracts, and Chapter 18 addresses how relative compensation may offer viable alternatives in the presence of joint costs for risk averse suppliers.
[2] For a strategic monopoly seller different approaches to pricing are optimal whether or not demand exceeds its capacity, as shown in optimal monopoly pricing analysis (e.g., Harris and Townsend 1981) The classes compared include fixed prices — linear or non linear, priority pricing in terms of decreasing preference for suppliers, and auction mechanisms.
[3] Several studies predicted electronic markets would play a significant role in redefining buyer–supplier relationships. For instance, www. freemarkets. com hosts reverse auctions on behalf of a buyer and identifies potential sources of supply to meet the requirements of the buyer, along with the price and the quantity to be awarded to each supplier.
[4] Weber *et al.* (1991) provides a review of research on supplier selection methods using full information approaches.
[5] You (2000) deals with a sequential buying process, where purchase of a certain number of units of an item at the lowest total purchasing cost must happen within a given number of time periods. He develops a dynamic model of pricing policies and search rules for the decision maker. In another sequential model, Gallien and Wein (2000) examine information asymmetry and incentive compatibility in industrial procurement under capacity constraints with multiple rounds of bidding.
[6] Klotz and Chatterjee (1995) and Lee (2000) study learning effects in sequential multiple sourcing arrangements. Their models confirm the advisability of equal splits.
[7] Analogous to Harris and Townsend (1981) results for the monopoly seller situation.
[8] See Hazra, Mahadevan and Seshadri (2004) for elaboration and modeling results.
[9] Greer and Liao (1986) report empirical evidence of suppliers charging higher prices at higher utilization in the aerospace industry. See Chapter 2 for a fuller discussion.
[10] The procurement market has n eligible vendors who participate, of whom k will be selected as suppliers. All k suppliers will get an equal allocation of the required capacity priced at the $(k+1)th$ lowest supplier bid. The fraction of required capacity the buyer awards to the i^{th} supplier is therefore Λ /k.
[11] See Exhibit 8.1 for a graphical view; the required number is k=2 in the Exhibit; therefore the *second quantity* award price $P^* = P(k=1)$ in the Exhibit.
[12] This award type is not hitherto analyzed or reported in the literature, to the best of the author's knowledge, and hence represents an innovation in sourcing design.
[13] Cost pools of manufacturing, material handling, quality control, fringe benefits are identified by Cohen and Loeb (1990). Possible output measures for allocation are direct material, direct labor dollars, direct labor hours.
[14] The analysis and this intuition are provided by Cohen and Loeb (1990).
[15] For sourcing strategy from risk averse suppliers in the presence of joint cost allocations, see Chapter 18.

Chapter 15

Covisint is a well known example. Direct material purchasing under contracts is a major web exchange domain. Current advances are standardized and automated purchase orders, invoicing and web enabling purchase authorization processes across multiple web exchange members.

[2] For instance, one web exchanges at the national level for bearings has over sixty members, among over three thousand independent dealers. Sometimes particular buyers post RFQ requirements for several thousand bearings. Half-a-dozen or more member bearing dealers will respond with private per unit bids on equivalent specs of different brands. If the buyer accepts, he splits the purchase among selected vendors based on some split award scheme, usually involving discriminatory per unit prices.
[3] Split buy biding models are analyzed in Anton and Yao (1989); multiple unit awards are analyzed in Seshadri, Lilien and Chatterjee (1991); Seshadri (1995); Klotz and Chatterjee (1995).
[4] See Pratt (2000) for several examples and the foundation analysis of syndicates.
[5] Moody and Kruvant (1990) builds regression models on OCS data to establish these results.
[6] Pratt (2000) provides a review of the general theory and assessment of sharing rules.
[7] Spot utilities are opportunity cost in the spot market on a risk-adjusted utility scale.
[8] This is not exactly in the ratio of reserve utilities in discriminatory auctions, as Supplier A's and Supplier B's bids are not exactly truthful revelations of their spot utilities, but are padded to varying degrees.
[9] There is a close correspondence between the progressively higher spot utility from booked capacity in the spot market and the reserve price-capacity curve of chapter 14.
[10]The base spot utility corresponds to a base level of profitability, determined by the economic rate of return on capacity.
[11] The bid price is driven by the spot utility required by the vendor converted into price terms. Recall that it is comprised of a fee after factoring in the risk premium in addition to required margin and expected costs.
[12] The sellers may be in remote and different locations and indicate by pressing a button when they wish to exit the reverse auction. The exit is easily kept private by the buyer from the other sellers.

Chapter 16

[1] The signaling equilibrium concept is the usual (PBE) Perfect Bayesian Equilibrium concept (see Fudenberg and Tirole 1989). The signaling action space is continuous, with equity q in the range $[q_{min}, q_{max}]$; and the firm type is continuous, with cost estimate z in the range $[z_{min}, z_{max}]$.
[2] The analysis is similar to Leland and Pyle (1977) for financial structures.
[3] This is the signaling equilibrium condition as first formulated by Spence (1974).
[4] The threshold value depends on the expected cost, the equity share that signals the actual cost, and the risk premium – given by sharing rate, discount rate, equity share, variance, and risk aversion.
[5] Samuelson (1986) shows that a "signaling contract" may be superior to a linear incentive contract at the bidding stage under some specific cost structures.

Chapter 17

[1] For instance, Rajgopal and Bernard (1993) report that pricing deals with multinationals cover long-term suppliers for as many as ten years ahead. Riordan and Sappington (1989) describe how defence procurement of development and production services span several years over the life of the acquisition program.
[2] McAfee and McMillan (1986) show that the LIC is optimal for single sourcing when bidding for contracts as it trades off incentives for effort with risk sharing and increased selection competition.
[3] See §7.4 for a basic LIC description.
[4] Cohen and Loeb (1990) view these allocated costs as highly unpredictable.
[5] This formulation is similar to Harrison (1990). Newman (1989) discusses possible costs relevant to sourcing decisions that correspond to this structure.
[6] Cohen and Loeb (1990) use a straightforward allocation function based on fraction of total business represented by procurement.

[7] Samuelson (1986) shows that bidding for LICs significantly improve welfare over fixed or cost plus contracts. The gains are due to risk bearing and incentive improvements.
[8] A few approaches have been proposed to determine the sharing rate when auctioning incentive contracts to risk neutral bidders. For instance, Laffont and Tirole (1987) show the optimal sharing rate depends on the hazard rate, which is unaffected by bidding. Our strategy requires the optimal sharing parameter for risk averse bidders, analyzed in McAfee and McMillan (1986), and Seshadri (1995).
[9] The translation of prices to utilities is monotonic, with a higher bid price implying a unique higher bid utility and vice versa. The analysis of equilibrium bids in utility space is simpler than that that for price for risk averse vendors. The corresponding price can always be recovered by adjusting for risk premium, margins and costs. The understanding of the effects of bidding and contracting in utility space is a great simplification for a first cut of results.
[10] Recall that McAfee and McMillan (1987) show that LICs are optimal for the tradeoff between adverse selection and moral hazard.
[11] The Pratt-Arrow measure of absolute risk aversion is constant in the exponential utility function, and explains the popular name, CARA.

Chapter 18

[1] This decoupling is important for political reasons when government funding for multi-year programs cannot be initially determined in annual budgets. Economic reasons also favor decoupling for instance when risk averse vendors can make transferable and unobservable investments.
[2] Samuelson (1986) shows that opportunity costs are important in deciding the limitations of bids for incentive contracts, and that allowing the sharing rate to be bid is an improvement within the single source approach. He terms this the "signaling contract."
[3] Riordan and Sappington (1989) refer to this strategic concern in second sourcing design and production.
[4] Nalebuff and Stiglitz (1983) demonstrate the basic principles of cost containment contests, and introduce many of the pertinent issues.
[5] We also referred to the need to decouple design and production phases in Chapter 17.
[6] Riordan and Sappington (1989) discuss a similar time line for defence projects. A development stage precedes a production stage. The development stage involves bidding for a development contract; based on realized value and observed cost the buyer awards the production contract. Compensation follows in the form of a discounted net present value of combined long term payoffs.
[7] Hiller and Tollison (1978) have an assessment of cost-plus contracts from empirical studies.
[8] Schill (1985) discusses a pooled fee for the single agent case; Anton and Yao (1992) discusses pooled fees for split awards; Seshadri (1995) discusses pooled fees for the dual source contest.
[9] Rogerson (1989) describes procurement in the defense sector and develops a theoretical argument leading to the conclusion that prizes for innovation are required in procurements where innovation is desirable.
[10] Mayer (1987) reports FSD without competition led to 40.2% cost growth, whereas those that were competitive had a mere 2%; in the production phase the corresponding figures were 12.7 % and 9.65 %.
[11] Riordan and Sappington (1989) argue that second source production mitigates excessive supply of R&D. Share of business awards work similarly to reduce the incentives for higher than socially optimal R&D supply, improving supply base welfare. This argument makes share of business awards preferable to winner's purse awards. The buyer can also commit to the share, removing another problem they observe in phased sourcing. Seshadri (1995) discusses this share, which is a sub-game perfect Nash equilibrium.
[12] Macbeth (1987) was an early prediction of fundamental change in buyer-seller relationships.

References

Atiyah P.S. *An Introduction to the Law of Contract.* New York: Oxford University Press, 1995.

Anderson S.D., Patil S.S., Sullivan, G. Optimizing owner/contractor core competencies for capital programs. Journal of Management in Engineering 2001; 17, 2: 77-85.

Akerlof, G. A. The Market for "Lemons": Quality Uncertainty and the Market Mechanism. The Quarterly Journal of Economics 1970; 84, 3: 488-500.

Ali A., Seshadri S. Customer Perception and Competitive Quality Strategy. Managerial and Decision Economics 1993; 14, 3: 235-246.

Ansubel L M., Cramton P. Demand reduction and inefficiency in multi-unit auctions. Working Paper 96-07, University of Maryland, 1996.

Anton J. J., Yao D.A. Second Sourcing and the Experience Curve: Price Competition in Defense Procurement . The RAND Journal of Economics 1987; 18, 1: 57-76.

Anton J.J., Yao D.A. Split awards, procurement and innovation. RAND Journal of Economics 1989; 20, 4: 538-552.

Anton J.J., Yao D.A. Coordination in split award auctions. The Quarterly Journal of Economics 1992: 681-707.

Anton J.J. Equilibrium bids and scale economies in split-award auctions. Working Paper, Economics Department, Duke University, 1995.

Argyres N.S. Evidence on the role of capabilities in vertical integration decisions. Strategic Management Journal 1996; 17, 5: 129-150

Arozamena L., Cantillon E. Investment incentives in procurement auctions. Review of Economic Studies 2004; 71: 1-18.

Arrow K.J. *Essays in the theory of risk-bearing*. Chicago: Markham, 1971.

Aw B. Y., Roberts M.J. The Role of Imports from the Newly-industrializing Countries in U.S. Production. The Review of Economics and Statistics 1985; 67, 1: 108-117.

Baiman S. Agency research in managerial accounting: a survey. Journal of Accounting Literature 1982: 154-213.

Bajari P., McMillan R., Tadelis, S. Auctions vs negotiations in procurement: An empirical analysis. Department of Economics, Working Paper, Stanford University, 2002.

Bakos Y. Reducing Buyer Search Costs: Implications for Electronic Marketplaces. Management Science 1997; 43, 12: 1676-1692.

Banerjee A.V., Duflo E. Reputation effects and the limits of contracting: A study of the Indiam software industry. Department of Economics, Massachussetts Institute of Technology, Working Paper, 2000.

Banker R.D., Hughes J.S. Product Costing and Pricing. The Accounting Review 1994; 69, 3: 479-494.

Baron D.P. Incentive Contracts and competitive bidding. American Economic Review 1972; 62: 284-294.

Barron J.M., Gjerde, K.P. Peer Pressure in an Agency Relationship Journal of Labor Economics 1997; 15, 2: 234-254.

Basu S. Procyclical productivity: Increasing returns or cyclical utilization. The Quarterly Journal of Economics 1996; 111, 3: 719- 751.

Benoit J-P., Krishna, V. The folk theorems for repeated games: a synthesis. Working Paper, Department of Economics, Penn State University, 2000.

Bensaou M., Anderson E. Buyer-supplier relations in industrial markets: when do buyers risk making idiosyncratic investments? Organization Science 1999; 10: 460-481.

Bergen M., Dutta S., Walker O.C. Agency relationships in marketing: A review of the implications and applications of agency and related theories. Journal of Marketing 1992; 56: 1-24.

Bolton P., Whinston M.D. Incomplete Contracts, Vertical Integration, and Supply Assurance The Review of Economic Studies 1993; 60, 1: 121-148.

Borger D., Liao S.S. Dual awards and contractor gaming in defense procurement, Competition and Cost Analysis Session, TIMS/ORSA, Washington DC, 1988.

Bower A.G. Procurement Policy and Contracting Efficiency International Economic Review 1993; 34, 4: 873-901.

Bower A.G., Osband, K. When More is Less: Defense Profit Policy in a Competitive Environment The RAND Journal of Economics 1991; 22, 1: 107-119.

Brown A.O., Lee, H.L. Optimal pay to delay capacity reservation with applications to the semiconductor industry. Stanford University, Working Paper, 1997.

Brynjolfsson, E. Information Assets, Technology, and Organization. Management Science 1994; 40: 1645-1662.

Bulow J.L., Roberts J.D. The Simple Economics of Optimal Auctions. The Journal of Political Economy 1989; 97, 5: 1060-1090.

Bulow J.L., Roberts J. D. Auctions versus negotiations. American Economic Review 1996; 86, 1:180-94.

Bulow J.L., Klemperer, P. Auctions Versus Negotiations. The American Economic Review 1996; 86, 1: 180-194.

Cachon G.P., Lariviere, M.A. Capacity Choice and Allocation: Strategic Behavior and Supply Chain Performance. Management Science 1999; 45, 8: 1091-1108.

Canes M. The simple economics of incentive contracting: Note. American Economic Review 1975; 65: 478-483.

Capen E.C., Clapp R.V., Campbell W.M. Competitive bidding in high risk situations. Journal of Petroleum Technology 1971; 23, 6: 641-653.

Catling J.R., Westwood J.B. A simulation approach to Cost Estimation in the project contracting industry. The Journal of the Operational Research Society 1985; 36, 4: 289-96.

Chen J., Yao D.D., Zheng S. Optimal replenishment and rework with multiple unreliable supply sources. Operations Research 2001; 49, 3: 430-443.

Chiesa V., Manzini R., Tecilla F. Selecting sourcing strategies for technological innovations: an empirical case study. International Journal of Operations & Production Management 2000; 20, 9: 1017-1037.

Chatterjee K., Lilien G.L. Game theory in marketing science: Uses and limitations. International Journal of Research in Marketing 1986; 3: 79-93.

Coase R.H. The Marginal Cost Controversy. Economica, New Series 1946; 13, 51: 169-182.

Cohen S.I., Loeb M. Implicit Cost Allocation and Bidding for Contracts. Management Science 1990; 36, 9: 1133-1138.

Corbett C.A., deCroix G.A. Share- savings contracts for indirect materials in supply chains: Channel profits and environmental impacts. Management Science 2001; 47, 7: 881-893.

Corbett C.J., Tang C.S. Designing supply contracts: contract type and information asymmetry. In *Quantitative Models for Supply Chain Management*, Tayur S., Magazine M. and Ganesan R. Editors. Kluwer Academic Publishers, 1998: 269-297.

Cox J.C., Isaac R.M., Cech P-A., Conn D. Moral hazard and adverse selection in procurement contracting. Games and Economic Behavior 1996; 17: 147-176.

Crocker K.J., Reynolds K.J. The efficiency of incomplete contracts: An empirical analysis of Air Force engine procurement. The RAND Journal of Economics 1993; 24: 126-146.

Crosby L.A., Evans K.R., Cowles D. Relationship Quality in Services Selling: An Interpersonal Influence Perspective. Journal of Marketing 1990; 54: 68-81.

Cummins J.M. Incentive contracting for national defense: A problem of optimal risk sharing. The Bell Journal of Economics 1977; 8: 68-185.

DaRold C., Grigg J., Berg T. How to build a sourcing strategy. Gartner: Strategic analysis report, R-18-1099, 2002.

Dasgupta S., Spulber, D.F. Managing procurement auctions. Information Economic and Policy 1990; 4: 5-29.

Davis D.D., Holt C.A., *Experimental Economics*. Princeton: Princeton University Press, 1993.

De Fontenay C.C., Gans J.S. Supply competition and outsourcing: A bilateral bargaining approach. Working Paper, Melbourne Business School, 2004.

Degraeve Z., Roodhooft F. Determining sourcing strategies: A decision model based on activity and cost driver information. The Journal of the Operational Research Society 1998; 49, 8: 781-789.

De Groot H.L.F. Macroeconomic consequences of outsourcing. Working Paper, Tilberg University, The Netherlands, 1998.

Dekkers R. Strategic capacity management: meeting technological demands and performance criteria. International Journal of Production Research 2002; 40, 15: 3895-3911.

Demski J.S., Kreps, D.M. Models in Managerial Accounting. In Supplement: Studies on Current Research Methodologies in Accounting: A Critical Evaluation. Journal of Accounting Research 1982; 20: 117-148.

Deng S-J., Elmaghraby W.J. Supplier selection via tournaments. Working Paper, School of Industrial and Systems Engineering, Georgia Institute of Technology, 2002.

Degraeve Z., Roodhooft, F. Determining Sourcing Strategies: A Decision Model Based on Activity and Cost Driver Information. The Journal of the Operational Research Society 1998; 49, 8: 781-789.

Dobler, D.W., Burt D.N., Lamar Lee L. Jr., *Purchasing and Materials Management*. New York: McGraw Hill Publishing Company, 1990.

Dwyer R.F., Schurr, P.H., Oh, S. Developing Buyer-Seller Relationships. Journal of Marketing 1987; 51: 11-27.

Dyer D., Kagel J.H., Levin D. A comparison of naïve and experience bidders in common value offer auctions: a laboratory analysis. Economics Journal 1989; 99: 108-115.

Eisenberg M.A. Why there is no law of relational contracts. Northwestern University Law Review 2000; 94, 3: 805–821.

Elmaghraby W.J. Supply contract competition and sourcing policies. M S Operations Management 2000; 2, 4: 350-371

Engelbrecht-Wiggans, R. Auctions and bidding models: A survey. Management Science 1980; 26, 2: 119-142.

Engelbrecht-Wiggans R. On optimal reservation prices in auctions. Management Science 1987; 33, 6: 763-770.

Engelbrecht-Wiggans R. On a possible benefit to bid takers from using multi-stage auctions Management Science 1988; 34, 9: 1109-1120.

Estache A., Quesada L. Concession contract renegotiation: some efficiency versus equity dilemmas, World Bank Policy Research Working Paper 2705, 2001.

Evans J. R., and Laskin R.L. The Relationship Marketing Process: A Conceptualization and Application. Industrial Marketing Management 1994; 23: 439-452.

Evers P.T. Filling customer orders from multiple locations: A comparison of pooling methods. Journal of Business Logistics 1999; 20, 1: 121-39.

Ewerhart C., Fiesler K. Procurement auctions and unit-price contracts. RAND Journal of Economics 2003; 34, 3: 569-81.

Fath G., Sarvary M. A model of B2B exchanges. Working Paper, Harvard Business School, Boston, 2001.

Feinman J.M. Relational contract theory in context. Northwestern University Law Review 2000; 94, 3: 737–748.

Fine C.H, Vardan R., Pethick R.,el-Hout, J. Rapid response capability in value chain design. MIT Sloan Management Review 2002: 69–75.

Fishner S., *A Report on Government Procurement Practices*. Virginia: Camelot Publishers, 1989.

Ford D. The Development of Buyer-Seller Relationships in Industrial Markets. European Journal of Marketing 1980; 14: 339-353.

Fudenberg D., Tirole J. Noncooperative game theory for industrial organization: An introduction and overview. Chapter 5 in *Handbook of Industrial Organization, Vol. 1 and 2.* Schmalensee R., Willig R.D. Editors. North Holland 1989: 259-327.

Furst O., Melumad N. Consider outsourcing even what you do best. Working Paper, Yale School of Management / Columbia Business School, 1999.

Gallien L.M., Wein, J. Design and analysis of a smart market for industrial procurement. Working paper 122, Sloan School of Management, MIT, 2000.

Ganesh J., Madanmohan T.R., Jose P.D., Seshadri S. Adaptive strategies of firms in high velocity environments: The case of B2B electronic marketplaces. Journal of Global Information Management 2004; 12, 1: 41-59.

Gansler J.S. *Defense conversion: transforming the arsenal of democracy*. Cambridge and London: MIT Press, 1995.

Gates W. DoD procurement policy: An evolutionary perspective. Working Paper, California Institute of Technology, 1987.

Gates W., Midler J.L. Cost growth in major army weapon systems acquisition: a synthesis of five case studies, AC-RR-65-004, California Institute of Technology, 1985.

Ghodsypour S.H., O'Brien C. A decision support system for supplier selection using an integrated analytic hierarchy process and linear programming. International Journal of Production Economics 1998; 56, 7: 199-212.

Giliberto S.M., N.P.Varaiya. The winner's curse and bidder competition in acquisitions: Evidence from failed bank auctions. Journal of Finance 1989; 44: 59-75.

Goldberg V.P. Price adjustment in long term contracts. Wisconsin Law Review 1985: 527-543.

Granovetter M., Economic action and social structure: The problem of embeddedness. American Journal of Sociology 1985; XCI: 481-510.

Greer, Jr., W.R., Liao S.S. An analysis of risk and return in the defense market: Its impact on weapon system competition. Management Science 1986; 32, 10: 1259-1273.

Grey W., Olavson T., Shi D. The role of e-market places in relationship based supply chains. IBM T.J. Watson Research Centre, Working Paper, 2002.

Grönroos, C., 1995. Relationship Marketing: The Strategy Continuum,.Journal of the Academy of Marketing Science 23 4, pp. 252-254.

Grossman G.M., Helpman E. Integration vs. outsourcing in industry equilibrium. CESifo Working Paper, Center for Economic Studies & Ifo Institute for Economic Research, Munich, 2001.

Grossman G.M., Helpman E. Outsourcing in a global economy. Harvard Institute of Economic Research, Discussion Paper, 2002.

Grossman S., Hart O. An analysis of the principal-agent problem. Econometrica 1983; 51: 7-45.

Gupta A.K., Seshadri S. Horizontal resource sharing. In AMA Best Papers Proceedings. Dallas, 1994.

Gundlach G.T., Achrol R.S., Mentzer J.T. The structure of commitment in exchange. Journal of Marketing 1995; 59: 78-92.

Hansen R.G. Auctions with endogenous quantity. RAND Journal of Economics 1988; 19, 1: 44- 58.

Hanson J.D., Logue K.D. The first-party insurance externality: an economic justification for enterprise liability. Cornell Law Review 1990; 76: 129-196

Hanson W., Wilson L.O. Supplier competition when diversity is important to the buyer. Working paper, Purdue University / AT&T Bell Laboratories, 1990.

Harris M., Raviv A. Allocation mechanisms and the design of auctions. Econometrica 1981; 49: 1477-99.

Harris M., Townsend R.M. Resource Allocation Under Asymmetric Information Econometrica 1981; 49, 1: 33-64.

Harrison J.R. A model for sealed bid auctions with independent value and common value components. Managerial and Decision Economics 1990; 11: 123-125.

Harrison J.R, March J.G. Decision making and post decision surprises. Administrative Science Quarterly 1984; 29: 26-42.

Harsanyi J.C. Games with incomplete information played by Bayesian players: Parts I, II, and III. Management Science 1967; 14: 159-182.

Hart O.D., *Firms Contracts and Financial Structure.* Oxford: Clarendon Press, 1995.

Hart O.D., Holmstrom B. The Theory of Contracts. In Bewley T.F. *Advances in Economic Theory*, Editor. Cambridge: Cambridge University Press, 1987: 71-155

Hazra J., Mahadevan B., Seshadri S. Capacity allocation among multiple suppliers in an electronic market. Production and Operations Management 2004; 13, 2: 161-170.

Henderson J.V.Evidence on scale economies and agglomeration. Brown University WP No. 98-22, Working Paper, 1998.

Henig M., Gerchak Y., Ernst R., Pyke D.F. An inventory model embedded in designing a supply contract. Management Science 1997; 43: 184 – 189.

Hergert M., Morris D. Accounting data for value chain analysis. Strategic Management Journal 1989; 10, 2: 175-188.

Hiller J.R., Tollison R.D. Incentive versus cost-plus contracts in defense procurement. Journal of Industrial Economics 1978: XXVI, 3: 239-248.

Hohner G., Rich J., Ng E., Reid G., Davenport A.J., Kalagnanam J.R., Ho S.L., An C. Combinatorial and quantity discount procurement auctions benefit Mars, Incorporated and its suppliers. INTERFACES 2003; 33, 1: 23-35.

Holm D.B., Eriksson K., Johanson J. Business networks and cooperation in international business relationships. Journal of International Buisness Studies 1996; 27: 1033-1053.

Holmstrom B. Moral hazard and observability. The Bell Journal of Economics 1979; 10, 1: 74-91.

Holmstrom B. Moral hazard in teams .The Bell Journal of Economics 1982; 13, 2: 324-340.

Holmstrom B., Milgrom P. The firm as an incentive system. The American Economic Review 1994; 84, 4: 972-991.

Hong H., Shum M. Increasing competition and the winner's curse: Evidence from procurement. Review of Economic Studies 2002; 69: 871-898.

Holt C.A. Uncertainty and bidding for incentive contracts. American Economic Review 1979; 69: 697-705.

Horngren C.T., *Introduction to Management Accounting*. New Jersey: Prentice Hall, 1981.

Hubbard R. G., Weiner R.J. Long-term contracting and multiple-price systems. The Journal of Business 1992; 65, 2: 177-198.

Hutt M., Speh T., *Business Marketing Management*. South Western College Publishing, 2003.

Itoh H. Incentives to Help in Multi-Agent Situations. Econometrica 1991; 59, 3: 611-636.

Jap S.D. An exploratory study of the introduction of online auctions. Journal of Marketing 2003; 69: 96-107

Jin M., Wu S.D. Modeling capacity reservation in high tech manufacturing. Department of Industrial and Systems Engineering, P.C. Rossin College of Engineering, Lehigh University, Working Paper, 2001.

Kagel J.H., Levin D. Independent private value auctions: Bidder behaviour in first-,second-, and third price auctions with varying numbers of bidders. Economic Journal 1993; 103: 868-869.

Karpoff J.M., Lee D.S., Vendrzyk V.P. Defense procurement fraud, penalties, and contractor influence. The Journal of Political Economy 1999; 107, 4: 809-842.

Katz A. When should an offer stick? The economics of promissory estoppel in preliminary negotiations. The Yale Law Journal 1996; 105: 1249 -- 1309

Keeney R.L., Raiffa H. Decisions with multiple objectives: Preferences and value tradeoffs. New York: Wiley, 1976.

Keough M. Purchasing matters: Buying your way to the top. McKinsey Quarterly 1993: 41-62.

King I., Welling L., McAfee R.P. Investment decisions under first and second price auctions. Economics Letters 1992; 39: 289-293.

Klein M. Bidding for concessions – the impact of contract design in public policy for the private sector. World Bank Report No. 18682, 1998.

Klemperer P. Auction theory: A guide to the literature. Journal of Economic Surveys 1999; 13, 3: 227-286.

Klemperer P. What really matters in auction design. Journal of Economic Perspectives 2002; 16, 1: 169-189.

Klotz D.E., Chatterjee K. Dual Sourcing in Repeated Procurement Competitions. Management Science 1995; 41: 1317-1327.

Kohli U.R. A gross national product function and the derived demand for imports and supply of exports. The Canadian Journal of Economics 1978; 11: 167-82.

Konishi H., OkunoFujiwara M. Competition through endogenized tournaments: An interpretation of "face-to-face" competition. Journal of the Japanese and International Economies 1996; 10, 3: 199-232.

Krishna V., *Auction Theory*. San Diego: Academic Press, 2002.

Krishna V., Perry M. Efficient Mechanism Design. Working Paper, Dept of Economics, Penn State University, 2000.

Krishnaswami S., Subramaniam V. The impact of capital structure on efficient sourcing and strategic behavior. The Financial Review 2000; 35: 9-30.

Lacity M.C., Willcocks L.P. An Empirical Investigation of Information Technology Sourcing Practices: Lessons from Experience. MIS Quarterly 1998; 22, 3: 363-408.

Laffont J-J., *The Economics of Uncertainty and Information*. Cambridge: The MIT Press, 1989.

Laffont J-J., Tirole J. Auctioning incentive contracts. The Journal of Political Economy 1987; 95, 5: 921-937.

Laffont J-J., Tirole, J. Repeated auctions of incentive contracts, investment, and bidding parity with an application to takeovers. RAND Journal of Economics 1988; 19, 4: 516 – 537.

Laffont J-J., Tirole, J. Adverse Selection and Renegotiation in Procurement The Review of Economic Studies 1990; 57, 4: 597-625.

Laffont J-J., Tirole, J. *A Theory of Incentives in Procurement and Regulation*. Cambridge: The MIT Press, 1993.

Langlois R.N. The vanishing hand: The changing dynamics of industrial capitalism. Working Paper, University of Connecticut, 2002.

Lawrence D. An aggregator model of Canadian export supply and import demand responsiveness. The Canadian Journal of Economics 1989; 22, 3: 503-521.

Lazear E.P., Rosen S. Rank-order tournaments as optimum labor contracts. The Journal of Political Economy 1981; 89, 5: 841-864.

Lebrun B. Existence of an equilibrium in first price auctions. Economic Theory 1996; 7: 421-443.

Lebrun B. First price auction in the asymmetric N bidder case. International Economic Review 1999; 40: 125- 142.

Lee K. S. Production cost, transaction cost, and outsourcing strategy: A game theoretic analysis. Working Paper, School of Business Administration, National University of Singapore, 2000.

Lee H.L. Aligning supply chain strategies with product uncertainties. California Management Review 2002; 44,3: 105-119.

Lee D.M.S, Trauth E.M., D. Farwell. Critical skills and knowledge requirements of IS professionals: A joint academic/industry investigation. MIS Quarterly 1995; 19: 313-340.

Leland H., Pyle D.H. Informational asymmetries, financial structure, and financial intermediation. The Journal of Finance 1977; 32: 371-87.

Leland H.E. Quacks, lemons, and licensing: A theory of minimum quality standards. The Journal of Political Economy 1979; 87, 6: 1328-1346.

Levy N. The organization of supply: A vertical equilibrium analysis. Working Paper, Department of Economics, University of Albany, SUNY, 2004.

Lewis T.R., Sappington D.E.M. Information Management in Incentive Problems. The Journal of Political Economy 1997; 105, 4: 796-821.

Li C-L., Kouvelis P. Flexible and risk-sharing supply contracts under price uncertainty. Management Science 1999; 45, 10: 1378-1398.

Liu A.H., Bernhardt K.L., Leach M.P. Examining customer value, satisfaction and switching costs in multiple-sourcing purchase decisions for business services. Penn State University, ISBM Report 6-1999,

Lowson R.H. Offshore sourcing? An optimal operational strategy? Business Horizons 2001: 61-66.

Lu X., McAfee R.P. The evolutionary stability of auctions over bargaining. Games and Economic Behavior 1996; 15, 228-254.

Luton R., McAfee R.P. Sequential procurement auctions. Journal of Public Economics 1986; 31: 181-195.

Lyon T.P. Does dual sourcing lower procurement costs? Working Paper, Kelley School of Business, Indiana University, 2002.

Macbeth D.K. Supplier management in support of JIT activity: A research agenda, International Journal of Operations & Production Management UK 1987; 7, 4: 53-63.

Macneil I. R. The many futures of contracts. Southern California Law Review 1974; 47: 691-816.

Macneil I.R. Contracts: Adjustment of long-term economic relations under classical, neoclassical, and relational contract law. Northwestern University Law Review 1978; 72, 6: 854 -905.

Macneil I. R., *The New Social Contract.* New Haven: Yale University Press, 1980.

Macneil I.R. Relational contract theory: Challenges and queries. Northwestern University Law Review 2000; 94, 3: 877–907.

Malone T., Yates J., Benjamin R. Electronic markets and electronic-heirarchies. Effects of information technology on market structure and corporate strategies. Communications of the ACM 1987; 30, 6: 484-497.

Manes R., Park S.H., Jensen R.E. Relevant costs of intermediate goods and services. The Accounting Review 1982; 57, 3: 594-606

Maskin E.S., Riley J.G. Optimal auctions with risk averse buyers. Econometrica 1984; 52, 6: 1473-1518.

Maskin E.S., Riley J.G. Uniqueness in sealed high-bid auctions. Mimeo, University of California Los Angeles, 1996.

Maskin E.S., Riley, J.G. Asymmetric auctions. Review of Economic Studies 2002; 67: 439-54.

Matthews S. Increasing competition and the winner's curse: Evidence from procurement. Review of Economic Studies 2002; 69: 871-98.

Mayer A. Military procurements: Basic principles and recent developments. George Washington Journal of International Law and Economics 1987; 21, 1: 165-187.

McAfee R.P., McMillan, J. Bidding for contracts: A principal-agent analysis. RAND Journal of Economics 1986; 17, 3: 326-338.

McAfee R.P., McMillan, J. Competition for agency contracts. RAND Journal of Economics 1987; 18, 2: 296-307.

McAfee R.P., McMillan, J. Auctions with entry. Economics Letters 1987; 23: 343-47.

McAfee R.P., McMillan, J. Government procurement and international trade. Journal of International Economics 1989; 26: 291-308.

McAfee R.P., McMillan, J. Optimal Contracts for Teams. International Economic Review 1991; 32, 3: 561-577.

McCall J.J. The simple economics of incentive contracting. American Economic Review 1970; 60: 837-846.

McMillan J., Whalley J., Zhu L. The Impact of ChinA's Economic Reforms on Agricultural Productivity Growth The Journal of Political Economy 1989; 97, 4: 781-807.

McMillan J., *Games, Strategies and Managers.* Oxford University Press, 1992.

McMillan, J., *Reinventing the Bazaar: A natural history of markets.* W.W.Norton & Co., 2002.

Mennemeyer S., Christianson J., Engelbrecht-Wiggans R., Ghemwat P. Competitive Bidding for Durable Medical Equipment and Clinical Laboratory Services: A Review of the Related Literature. Abt Associates, Inc.:Cambridge, MA, Report; 1987.

Milgrom P. and Weber R.J. The simple economics of optimal auctions. Journal of Political Economy 1982; 97, 5: 1060 –1090.

Min H. International supplier selection–a multiattribute utility approach. International Journal of Physical Distribution & Logistics Management 1994; 24, 5: 24-33

Mishra R., A generalized strategy-structure-process framework for dynamic evaluation of business market relationships: An episode level operationalization. Fellow Programme in Management, Indian Institute of Management Bangalore, Dissertation, 2001.

Moody C.E., Kruvant W.J. OCS leasing policy and lease prices. Land Economics 1990; 66: 30-39.

Morgan R.M., Hunt S.D. The commitment-trust theory of relationship marketing. Journal of Marketing 1994; 58: 20-38.

Myerson R. Optimal auction design. Mathematics of Operations Research 1981; 6: 58-73.

Naegelen F. Implementing optimal procurement auctions with exogenous quality. Review of Economic Design 2002; 7: 135-53.

Nalebuff B.J., Stiglitz J.E. Prizes and Incentives: Towards a General Theory of Compensation and Competition. The Bell Journal of Economics 1983; 14, 1: 21-43.

Narasimhan R., Stoynoff L. Optimizing aggregate procurement allocation decisions. Journal of Purchasing and Materials Manageent 1986: 23-30.

Newman R.G. Single sourcing: Short term savings versus long-term problems. Journal of Purchasing and Materials Management 1989; 25,2: 20-25

Noordewier T. G., John G., Nevin J. R. Performance outcomes of purchasing arrangements in industrial buyer-vendor relationships. Journal of Marketing 1990; 54: 80-93.

Nordberg M., Cambell A.J., Verbeke A. Can market-based contracts substitute for alliances in high technology markets? Journal of International Business Studies 1996; 27: 963-979.

Nyarko Y. Book Review. Journal of Economic Literature 1993; 31, 2: 890-891.

Ono Y. Outsourcing business services and the scope of local markets. Working Paper, Federal reserve Bank of Chicago, 2001.

Ortega-Reichert A. Models of competitive bidding under uncertainty. Technical Report No. 8, Department of Opertaions Research, Stanford University, 1968.

Paarsch H.J. Deciding between the common and private value paradigms in empirical models of auctions. Journal of Econometrics 1992; 51: 191-215.

Pan A. C., Ramasesh R.V., Hayya J.C., Ord J.K. Multiple Sourcing: The Determination of Lead Times. Operations Research Letters 1991; 10, 1:1-7.

Parasuraman A., Zeithaml V., Berry L. A conceptual model of service quality and its implications for future research. Journal of Marketing 1985: 41-50

Parsons J.E. Estimating the strategic value of long-term forward purchase contracts using auction models. The Journal of Finance 1989; 44, 4: 981-1010.

Park H.Y., Reddy C.S., Sarkar S. Make or buy strategy of firms in the US. Multinational Business Review 2000: 89-97.

Porter M.E. *Competitive Strategy: Techniques for analyzing industries and competitors.* New York: Free Press, 1985.

Porter M.E. *Competitive Advantage: Creating and Sustaining Superior Performance.* New York: Free Press, 1985.

Pownall G. An empirical examination of the regulation of the defense contracting Industry: The Cost Accounting Standards Board. Journal of Accounting Research 1986; 24, 2: 291-315.

Pratt J.W. Efficient risk sharing: The last frontier. Management Science 2000; 46, 12: 1545-1553.

Presutti W.D. The single source issue: US and Japanese sourcing strategies. Intenational Journal of Purchasing & Materials Management 1992; 28:2-9.

Puto C.P., Patton W.E. III, King R.H. Risk handling strategies in industrial vendor selection decisions. Journal of Marketing 1985; 49: 89-98.

Pyke D.F., Johnson M.E. Sourcing strategy and supplier relationships: Alliances vs eProcurement. Working Paper, Tuck School of Business, Dartmouth College, 2002.

Quinn J.B., Hilmer F.G. Strategic outsourcing. Sloan Management Review 1994.

Raffel D.E., Chatterjee K. Dual sourcing, learning, and constraints on borrowing. Working Paper, College of Business Administration, Penn State University, 1989.

Raiffa H., *Decision analysis. Introductory lectures on choices under uncertainty.* Massachusetts: Addison-Wesley, 1968.

Rajagopal S., Bernard K.N. Cost containment strategies: Challenges for strategic purchasing in the 1990s. International Journal of Purchasing and Materials Management 1993; 29,1: 17-23.

Ramasesh R.V., Ord J. K., Hayya J.C., Pan A. Sole versus Dual Sourcing in Stochastic Lead-Time (s, Q) Inventory Models. Management Science 1991; 37, 4: 428-443.

Rampy T.R. Allowable costs for Air Force contracts. The Accounting Review 1950; 25, 4: 371-77

Ramsay J., Wilson I. Sourcing/contracting strategy selection. International Journal of Operations & Production Management 1990; 10, 8: 19 – 28.

Rasmusen E., *Games and Information, Third Edition*. Oxford: Blackwell Publishers, 2001.

Reichelstein S. Constructing incentive schemes for government contracts: An application of agency theory (in a forum on accounting for defense contracts). The Accounting Review 1992; 67, 4: 712-731.

Richardson J., Roumasset J. Sole sourcing, competitive sourcing, parallel sourcing: Mechanisms for supplier performance. Managerial and Decision Economics 1995; 16, 1: 71-84.

Riley, J.G., Samuelson W.F. Optimal auctions. American Economic Review 1981; 71, 3:

Riordan M.H., Sappington D.F.M. Second sourcing. RAND Journal of Economics 1989; 20, 1: 41-58.

Rob R. The Design of Procurement Contracts. The American Economic Review 1986; 76, 3: 378-389.

Rogerson W.P. Profit regulation of defense contractors and prizes for innovation. The Journal of Political Economy 1989; 97, 6: 1284-1305.

Rogerson W.P. Overhead Allocation and Incentives for Cost Minimization in Defense Procurement (in A Forum on Accounting for Defense Contracts). The Accounting Review 1992; 67, 4: 671-690.

Rogerson W.P. Book Review. Journal of Political Economy 1994; 102, 2: 397-402

Rothkopf M.H. Bidding theory: the phenomenon to be modeled. In *Auctions, Bidding and Contracting: Uses and theory*. Engelbrecht-Wiggans R., Shubik M., Stark R.M., Editors. New York University Press, 1983: 105-120.

Rothkopf M.H., Harstad R.M. Modeling competitive bidding: A critical essay. Management Science 1994; 40, 3: 364-384.

Rothkopf M.H., Teisberg T.J., Kahn E.P. Why are Vickrey auctions rare? Journal of Political Economy 1990; 98: 94- 109.

Salanie B., *The Economic of Contracts: A Primer*. MIT Press, 2002.

Samuelson W.F. Competitive bidding for defense contracts, in *Auctions, Bidding and Contracting: Uses and Theory*, Engelbrecht-Wiggans R., Shubik M., Stark R.M. Editors. 1983:. 389-419,

Samuelson W.F. Bidding for contracts, Management Science 1986; 32, 12: 1533-1550.

Schmalensee R., Willig R.D. *Handbook of Industrial Organization, Vol 1 and 2.* Editors. North Holland, 1989.

Schill R.L. Managing risk in contract pricing with multiple incentives. Industrial Marketing Management 1985; 14: 1-16.

Scott R.E. The case for formalism in relational contract. Northwestern University Law Review 2000; 94, 3: 847 – 876.

Segal M.N. Implications of single v. multiple buying source. Industrial Marketing management 1989; 18: 163-178.

Serel D., Dada M., Moskowitz H. Sourcing decision with capacity reservation contracts. European Journal of Operational Research 2001; 131: 635 – 648.

Seshadri S. Implementing procurement objectives in business markets. Dissertation, Smeal School of Business, Penn State University, 1988.

Seshadri S., Chatterjee K., Lilien G.L. Multiple Source Procurement Competitions Marketing Science 1991; 10, 3: 246-263.

Seshadri S. Supplier Incentives and Resource Constraints under Uncertainty. Managerial and Decision Economics 1994; 15, 1: 49-56.

Seshadri S. Bidding for Contests. Management Science 1995; 41, 4: 561-576.

Seshadri S., Sharma Y. Structural models for government intervention in ecommerce. 2001; 33: 513-526.

Seshadri S. Outlet ownership in franchising systems. Managerial and Decision Economics 2003; 23, 6: 355-369

Seshadri S., Mishra R. Relationship marketing and contract theory. Industrial Marketing Management 2004; 33: 513-526.

Smith V.L. Rational Choice: The Contrast between Economics and Psychology The Journal of Political Economy 1991; 99, 4: 877-897.

Soon A., Cummings L.L. Strategic responses to institutional influences on information systems outsourcing. Organization Science 1997; 8, 3: 235-256.

Spence A.M. Job market signaling. Quarterly Journal of Economics 1973; 87: 355- 374.

Spence A.M. Competitive and optimal responses to signals: analysis of efficiency and distribution. Journal of Economic Theory 1974, 7: 296.

Stark R.M., Rothkopf M.H. Competitive bidding: A comprehensive bibliography. Operations Research 1979; 27: 364-90.

Stoljar S.A. The false distinction between bilateral and unilateral contracts. Yale Law Journal 1955; 64: 514 - 536

Taylor C.R., Wiggins S.N. Competition or compensation: Supplier incentives under the American and Japanese subcontracting systems. The American Economic Review 1997; 87, 4: 598-618.

Tayur S., Ganeshan R., Magazine M., *Quantitative models for supply chain management.* Boston: Kluwer Academic Publishers, 1999..

Tellis G.J., Wernerfelt B. Competitive Price and Quality Under Asymmetric Information. Marketing Science 1987; 6, 3: 240-253.

Tirole J., *The theory of industrial organization.* Cambridge: The MIT Press, 1988.

Trelevan M., Schweikhart S.B. A risk benefit analysis of sourcing strategies: Single vs multiple sourcing. Journal of Operations Management 1988; 7:93-114.

Trent R.J., Monczka R.M. Pursuing competitive advantage through integrated global sourcing. Academy of Management Executive 2002; 16, 2: 66-80.

Tsay A.A. The quantity-flexible contract and supplier-customer incentive. Management Science 1999; 45,10: 1339-1358.

Tyler S.M. No (Easy) way out: "Liquidating" stipulated damages for contractor delay in public construction contracts. Duke Law Journal 1994; 44: 357 – 435.

Tyworth J.E., Ruiz-Torres A. Transportation's role in the sole- versus dual-sourcing decision. International Journal of Physical Distribution & Logistics Management 2000; 30, 2: 128-44.

Varian H.R., *General equilibrium theory and welfare economics. Microeconomic Analysis.* New York: W.W. Norton & Co., 1984.

Venkatesan R. Strategic Sourcing: To make or not to make. Harvard Business Review 1992; 98-107.

Verwaal E., Verbeke W., Commandeur H.R. Value creation and value claiming in make-or-buy decisions. Working Paper, Erasmus research Institute of Management, 2002.

Vickrey W. Counterspeculation, auctions and competitive sealed tenders, Journal of Finance 1961; 16: 8-37.

Vickrey W. Auctions and biding games, Recent Advances in Game Theory, Princeton University Conference 1962: 15-27.

Vistnes G. An Empirical Investigation of Procurement Contract Structures The RAND Journal of Economics 1994; 25, 2: 215-241.

von Neumann J., Morgenstern O., *Theory of Games and Economic Behavior.* Princeton: Princeton University Press, 1947.

Vulcano G., Van Ryzin G., Maglaras C. Optimal dynamic auctions for revenue management. Working paper, Graduate School of Business, Columbia University, 2001.

Walker G. Asset choice and supplier performance in two organizations-US and Japanese. Organization Science 1994; 5, 4: 583-593.

Weber C., Current J., Benton W.C. Vendor selection criteria and methods. European Journal of Operations Research 1991; 50: 2-18.

Weber R..J., Multiple-object auctions. In *Auctions, Bidding and Contracting: Uses and theory.* Engelbrecht-Wiggans R., Shubik M., Stark R.M., Editors. New York University Press, 1983: 165-191.

Webster F.E. Jr., *Industrial Marketing Strategy.* New York: John Wiley & Sons, 1984.

Weeme P.T. Strategies for cutting costs: turning procurement into a virtuous cycle. Strategic Finance 2003: 39 –42

Williamson O.E., *Economic Organization: Firms, Markets and Policy Control.* New York: New York University Press, 1986.

Wilson D.T. An Integrated Model of Buyer-Seller Relationships. Journal of the Academy of Marketing Science 1995; 23 4: 335-345.

Wilson R.B. Auctions of shares, Quarterly Journal of Economics 1979; 93, 4: 675-90.

Yildirim H. Piecewise procurement of a large scale project. Duke University, Working Paper, 2003.

You P-S. Sequential buying policies. European Journal of OR 2000; 120, 3: 535- 544.

Zhagloul R., Hartman F. Reducing contract cost: The trust issue. AACE International Transactions CDR 2000; 16: 1-4.

Zhaohui Z.A. Single of multiple sourcing: an integrated optimization framework for sustaining time-based competitiveness. Journal of Marketing Theory and Practice 2001: 10-25.

Ziv A. Information Technology and Optimal Firm Structure Journal of Accounting Research 2000; 38, 2: 297-328.

Subject Index

accounting
  Cost 11, 67, 85, 92, 258, 291
  systems 15, 89
  GAO 70
  activity based costing, 74, 90
adverse selection
  problem, 84, 109, 174, 181, 288, 296
  competitive bidding and, 120, 141
agency
  costs 15, 60, 91
  mechanisms 109
  Principal-Agent 187
alliances
  Organizational forms 63
  Sourcing 105, 108
  Negotiations and 121
AMC 155
asset specificity
  human 15
  outsourcing 18
  production economies 19
auctions
  affiliated values 122, 130, 143, 150
  asymmetric 32, 35, 78, 108, 118, 128, 133, 135, 152, 174, 244, 288
  common value 122, 141, 143, 150
  efficiency 124, 135, 144, 222, 235
  for shares 42, 142, 230, 239, 241, 279, 285, 291
  private values 118, 122, 135, 143, 150, 178, 292
  optimal 111, 120, 125, 133, 144, 149, 152, 265, 293
  Vickrey 123, 129, 145, 148, 182, 208, 211, 216, 220, 236, 260, 274, 292
  winner's curse 74, 123, 150, 231, 277
awards
  discriminatory 72, 130, 144, 183, 234, 239, 274, 292, 295
  first-price 118, 126, 130, 182, 222
  second price 118, 123, 125, 130, 144, 170, 182, 211, 217, 220, 234, 274, 292
  split 24, 26, 68, 71, 116, 121, 131, 142, 165, 170, 200, 206, 211, 225, 230, 248, 274, 279, 280, 288, 295
  totem pole 129, 183, 236, 274
  uniform-price 104, 130, 194, 220, 226, 236, 278, 292
  winner-take-all 61, 71, 142, 175, 202

B2B exchanges 214, 230
bargaining 15, 21, 98, 104, 117, 121, 149, 291
bid

Price 26, 33, 57, 71, 77, 94, 101, 113, 120, 129, 139, 150, 170, 178, 182, 189, 194, 204, 222, 226, 231, 236, 260, 263, 269, 295
Numbers 25, 43, 120, 123, 125, 137, 148, 154, 182, 193, 196, 200, 219, 226, 231, 237, 282
Strategy 126, 129, 133, 136, 139, 143, 182, 194, 197, 212, 237, 276
BPO 16, 28, 109, 164, 281
BPR 93

capacity
Constraints 25, 35, 53, 82, 148, 170, 201, 206, 211, 214, 225, 230, 234, 243, 294
Reservation 106, 152, 197, 200, 208, 214, 217, 219, 225, 293
CARA 182, 231, 245, 261, 264, 296
COGS 20, 34
contests 24, 26, 55, 99, 103, 121, 132, 172, 174, 255, 270, 275, 296
contracts
bidding 42, 70, 109, 169, 213, 264, 288, 296
bilateral 21, 39, 78, 104, 119
capacity constrained 117, 172, 202, 211, 219, 224, 293
cost-plus 34, 61, 70, 82, 90, 95, 97, 110, 121, 171, 256, 260, 266, 270, 275, 277, 296
equity sharing 171, 243, 247, 295
fixed-price 43, 47, 85, 95, 98, 108, 122, 140, 153, 158, 170, 189, 208, 214, 224, 256, 260, 264, 272
incentive 2, 36, 42, 60, 70, 98, 108, 110, 140, 170, 175, 212, 224, 243, 245, 247, 252, 255, 257, 259, 264, 268, 280, 290, 294
incomplete 15, 22, 25, 37, 80, 108, 244
neoclassical 79, 104, 291
quantity 82, 103, 107, 117, 131, 172, 203, 214, 219, 223, 225, 278, 292
relational 79, 104, 107, 291
cost
accounting 11, 89, 258, 291
acquisition 2, 45, 51, 56, 60, 64, 68, 75, 82, 87, 126, 130, 149, 153, 170, 179, 181, 190, 195, 200, 206, 222, 260, 268, 276, 279
activity based 74, 90
drivers 2, 52, 74, 77, 87, 171, 257, 264, 270, 273
effort 27, 94, 97, 152, 191, 260, 268, 272, 279, 288
inventory 89, 207
marginal 61, 85, 87, 90, 97, 99, 104, 117, 133, 203, 212, 226, 262, 276, 288, 292
monitoring 27, 84, 91, 93, 288
opportunity 3, 14, 51, 56, 85, 87, 90, 97, 110, 116, 124, 126, 130, 135, 140, 154, 170, 179, 187, 197, 204, 212, 222, 229, 232, 240, 261, 272, 280
production 13, 41, 72, 119, 124, 145, 191, 214
search 45, 214, 216, 234
transaction 11, 14, 25, 35, 66, 104, 287
CRM 6, 17, 161
CU 69, 145, 147, 204, 218

database 19, 112, 155, 159, 75
defense 24, 61, 65, 141, 278, 288, 290, 296
diversity 21, 22, 111, 227
DOD 58, 67, 70, 72, 289

economies of scale 15, 21, 24, 26, 51, 72, 170, 202, 203, 275, 288
efficiency 18, 25, 32, 36, 45, 54, 60, 65, 72, 75, 79, 84, 95, 103, 107, 110, 124, 135, 144, 54, 162, 166, 181, 222, 235, 261, 265, 281, 288
entry 3, 7, 9, 21, 23, 52, 58, 87, 112, 119, 127, 130, 147, 149, 154, 170, 190, 212, 217, 224, 231, 275, 278, 288, 293
equilibrium
  Bayesian 169, 179, 295
  Nash 170, 180, 293, 296
  signaling 170, 174, 181, 251, 295, 296
equity 37, 53, 171, 173, 244, 247, 250, 295
ERP 16, 23, 162, 166, 213
experience curve 61, 72, 151, 261
experimental 32, 123, 194
externalities 21, 67

fraud 55, 58, 65, 70, 73, 289

globalization 13, 17, 28, 52

government
  procurement 70, 73, 291
  sourcing 2, 6, 26, 59, 64, 67, 73, 96, 117, 190, 244, 278

import 18
information asymmetry 35, 84, 107, 143, 169, 174, 188, 213, 235, 243, 294
innovation 7, 17, 76, 30, 39, 51, 60, 71, 91, 97, 104, 108, 132, 166, 171, 255, 256, 278. 296
insurance
  costs 15, 83, 85, 189, 260, 269, 276, 279
  rents 229, 262, 269
investment 22, 25, 34, 37, 52, 56, 57, 62, 70, 73, 93, 104, 108, 112, 117, 136, 152, 160, 171, 191, 199, 245, 252, 289, 292
inventory 6, 10, 54, 66, 72, 82, 89, 161, 165, 201, 207, 231, 289

JIT 57, 84, 162, 190, 281

learning curve 61, 71, 91, 151, 256, 259, 290
lead time 53, 56, 207
liquidated damages 77, 95, 291
lock-in 26, 37, 57
logistics 9, 16, 43, 51, 54, 67, 72, 78, 84, 131, 163, 205, 290

make or buy 13, 25, 28, 57, 148, 199, 287
materials
  bill-of- 112, 72
    direct 16, 68, 102, 156, 164, 258
  handling 161, 163
  raw 5, 244
mechanism
  award 112, 119, 124, 136, 141, 149, 159, 172, 177, 219
  auction/ bidding 111, 120, 125, 131, 136, 148, 153, 174, 177, 217, 220, 294
  contracting 102, 107
  design 120, 136, 145, 221
moral hazard 27, 36, 83, 87, 94, 97, 109, 174, 188, 245, 288, 296
MRO 16, 72, 156

negotiations 36, 61, 70, 80, 119, 132, 136, 149, 162, 292

OEM 9, 66, 121, 205, 239, 245, 246, 257, 271, 275
outsourcing 12, 17, 28, 52, 62, 74, 100, 155, 161, 230, 255, 261, 281,287

parallel
  markets 73, 170, 211, 225, 267

sourcing 62, 202, 219, 290
Pareto 39, 233, 288
performance
cost 95, 97, 259, 280
gains 154, 164
risk 60, 77, 79, 92, 260
principal-agent 11, 36, 169, 187, 287, 293
probability
distribution 35, 46, 81, 124, 140, 178, 182, 198, 203, 206, 258, 292
entry 197
of participation 150
of selection 135, 194
of winning 139, 191, 261, 276, 279
subjective 35, 179
processes
automated 10, 23, 290, 294
bidding 21, 70, 120, 130, 156, 200, 211, 232, 277
procurement 166, 290
sourcing 7, 9, 15, 23, 28, 31, 42, 52, 58, 67, 89, 94, 119, 154, 158, 179, 189, 203, 230, 279
workflow 3, 23, 75, 154
productivity 30, 34, 52, 63, 79, 91, 116, 162, 245, 249, 255, 258, 290
programming 14, 23, 54, 162, 180, 291
program management 109
property rights 35, 152

quality
certification 17, 54, 57
control 27, 84, 91, 93, 294
index 45, 144, 184

regulation 63, 70, 75, 175
relationship
continuity 40, 289
contract 43, 105
customer 6, 161, 246
financial 171, 173, 244, 252
long-term 10, 37, 109, 132, 190, 246
sourcing 5, 44, 92, 112, 116, 157, 211
supply/supplier 24, 63, 121, 128, 161, 244, 264, 294
rents
economic 83, 89, 97, 149, 261
information 60, 72, 103, 116, 118, 131, 142, 149, 152, 174, 234, 261, 265, 274, 289, 292
quasi 42, 70
reputation 38, 105, 120
resource sharing 27, 43, 53, 171, 173, 231, 243, 257, 287
revelation 111, 124, 128, 130, 135, 144, 170, 182, 220, 234, 274
revenue equivalence 118, 124, 126, 130, 133, 137, 170, 182
RFx 33, 45, 63, 74, 112, 115, 121, 151, 156, 167, 184, 193, 197, 217, 226, 230, 240, 282, 291, 295
risk
allocation 11, 171, 174, 243, 247, 252
aversion 35, 83, 94, 98, 151, 169, 174, 191, 231, 233, 239, 243, 250, 253, 264, 267, 274, 282, 285, 288, 295, 296
return 63, 170, 187, 200, 206, 231, 280
sharing 26, 43, 54, 82, 94, 102, 142, 170, 229, 231, 233, 238, 243, 247, 282, 288, 295

SBU 6, 11, 52, 89, 288
sequential 41, 43, 53, 57, 62, 119, 132, 137, 151, 154, 178, 294
shares 24, 42, 64, 142, 171, 185, 204, 230, 232, 236, 239, 241, 251, 260, 272, 279, 285, 291
signaling 170, 174, 181, 251, 295, 296
simulation 82, 291

software 1, 23, 29, 31, 44, 49, 108, 162, 169, 177, 184, 191, 213, 292
sourcing
dual 24, 26, 34, 40, 61, 68, 70, 100, 108, 130, 172, 204, 207, 264, 269, 274, 278, 280, 290, 293
global 6, 9, 51
multiple 24, 41, 51, 59, 72, 108, 128, 130, 137, 150, 154, 171, 190, 193, 197, 203, 207, 212, 288, 294
second 68, 104, 151, 291, 296
single 24, 57, 59, 62, 68, 91, 132, 193, 198, 200, 202, 206, 209, 269, 291, 295
sole 26, 68, 70, 113, 290
spot markets 2, 36, 41, 67, 77, 87, 107, 110, 117, 127, 170, 191, 200, 208, 211, 216, 224, 229, 232, 234, 243, 255, 261, 269, 271, 274, 278, 280
stochastic 54, 82, 97, 117, 124, 136, 141, 174
stock out 25, 56, 84, 160, 202, 204, 205
subcontracting 22, 68, 78, 80, 95, 145, 194, 231
supply assurance 53, 213
supply base
capacity 155, 170, 193, 206, 219
development 1, 170, 207
management 165
design 9, 45
welfare 145, 147, 296
supply chain 6, 23, 29, 36, 41, 43, 52, 58, 78, 82, 93, 102, 104, 107, 159, 162, 187, 194, 198, 201, 205, 231, 244, 246, 247, 252, 261
supply contract 62, 78, 82, 288, 291
syndicates 26, 54, 79, 170, 173, 229, 237, 295

teams 24, 27, 32, 52, 74, 261, 288
tenders 34, 45, 112, 117, 136, 194, 203, 205, 264
tiers 5, 27, 57, 68, 79
tournaments 26, 99, 104
trust 37, 39, 65, 74, 95, 108, 244
transaction cost 11, 14, 17, 25, 35, 66, 104

uncertain
cost 24, 26, 36, 59, 81, 101, 123, 187, 243, 247, 250, 257, 260
demand 90, 107, 216, 217, 225, 228, 229, 240
utility 94, 102, 114, 119, 126, 130, 140, 143, 145, 169, 179, 187, 221, 233, 245, 250, 260, 263, 266, 274, 279, 289, 293, 295

value
addition 16, 28, 30, 44, 64, 87, 161, 211
chain 5, 16, 18, 53, 89
expected 34, 81, 116, 119, 249
fair 184
net present 159, 269, 271, 273, 277, 290, 296
VCG mechanisms 145, 147, 220
verifiable 2, 27, 38, 93, 97, 99, 108, 171, 189, 247, 255, 259
vertical integration 14, 18, 35, 91, 104, 288

wages 15, 21, 60, 64
welfare 21, 30, 59, 64, 73, 83, 136, 145, 174, 187, 221, 230, 270, 296
winner's curse 74, 123, 150, 231, 277
winner's purse 172, 174, 272, 275, 277, 279, 284, 296
WTO 66, 75