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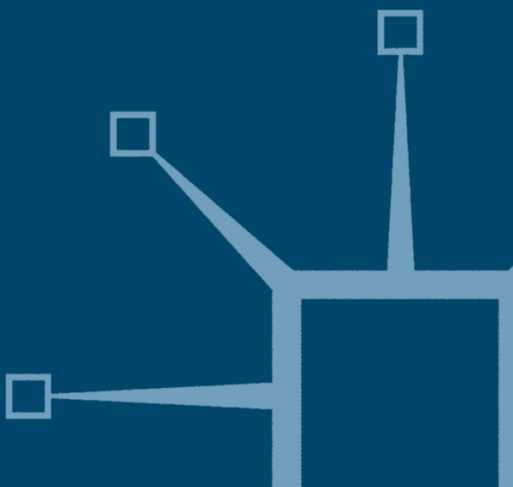
Learning E-Business and Development

Banji Oyelaran-Oyeyinka and
Kaushalesh Lal



SMEs and New Technologies

Also by Banji Oyelaran-Oyeyinka

LEARNING TO COMPETE IN AFRICAN INDUSTRY

SMEs and New Technologies

Learning E-Business and Development

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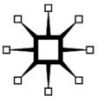

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1
New Technologies and Economic Development

1.1 Introduction

In recent times, considerable empirical studies have been undertaken to understand the precise ways in which new technologies, particularly information and communications technologies (ICTs),[1] have contributed to the process of knowledge accumulation and more importantly, how this has promoted economic performance.[2] These studies have been carried out at different levels of aggregation, namely establishments and plants, firms, industries or sectors and countries. Strikingly but not surprisingly, most of the studies were carried out within sectors and firms in industrialized economies. Although the review (Seigel et al., 1997; Lichtenberg, 1995) shows a skewed distribution in the trend of studies, there have been efforts within developing countries themselves, by scholars working on developing countries as well as by the United Nations, to understand the role of ICTs in the economic development of countries (UNCTAD, 2001, 2002, 2004; Lal, 2002, 2001; Oyelaran-Oyeyinka and Adeya, 2004; Oyelaran-Oyeyinka and Lal, 2004). There are studies that examine the specific impact of ICT policies and in fact suggest that good ICT policies help develop e-business (Bridges.org, 2001; Dekleva, 2000; Wolcott et al., 2001; Mbarika and Byrd, 2003; UNECA, 1999). However, there are gaps in two respects, that this book addresses. First, many of these studies in developing countries are at a high level of aggregation that makes it difficult to understand the differential effects of critical variables on economic performance. Second, the available sectoral and firm-level studies focus on single countries addressing several sectors, making cross-country comparisons difficult. Even then there are hardly any systematic studies on enterprise-level adoption of e-business addressing the context of underdevelopment.

This book seeks to address the adoption of e-business at the level of the enterprise through cross-country comparative studies of three countries at different levels of economic development: Nigeria, Uganda and India. We approach the study by employing different quantitative and qualitative techniques that focus on the broad issue of the role of new technologies and how they contribute to knowledge creation and accumulation in the process of development. This is important because economic progress depends critically on the ways in which nations and firms accumulate technological knowledge through progressive learning. This study approaches the issues by collecting firm-level data through questionnaires and direct interviews with enterprise owners and policymakers. Recent empirical evidence in developed countries shows substantial and increasing returns on IT investment, contrary to many earlier inconclusive findings. The stylized facts are as follows:

1. At the level of the firm, there is 'strong evidence of excess returns' on IT systems, equipment and labour investments (Lichtenberg, 1995).
2. There is a strong relationship between IT and improvements in economic performance of the USA and the impact of IT on aggregate economic performance has increased over time (Stiroh, 2001).
3. However, externalities are equally important. That is, the complementary effects of investments made in R&D, computers and human capital in other areas of the industry and sectors reinforce, and could in fact be indispensable to, the observed positive impact on productivity in a particular sector. In other words, ICTs should be seen in the category of what some economists conceptualize as a 'general purpose technology' (GPT). A GPT exerts widespread and productivity-raising effects in all parts of the economy and sector.
4. There is a time dimension to IT investment because of the learning effect of technological investment within which firms master techniques and by which 'network effects' begin to be felt. Policymakers should therefore plan for lags in investment. For instance, adoption of advanced manufacturing practices may require significant changes in work organization that may sometime be disruptive while making positive impact on productivity (Siegel et al., 1997).

It is for these reasons that the studies that led to this book adopted a systemic approach to capture the nature of externalities affecting firm-level performance. Again, deliberately, the country samples were drawn from clusters of small and medium enterprises (SMEs)[3] because these are the dominant productive actors in the economies of developing countries. As

most recent literature has observed, new technologies open a new and powerful door of opportunity to SMEs to expand their markets beyond local and national borders. SMEs lower the transaction costs of information-intensive activities that involve far-distant and relatively sophisticated clients by employing Internet-mediated ICTs. In particular, ICTs have also emerged as significant shop-floor production tools by which firms develop flexibility and speed in manufacturing high-quality and specialized products. The adoption of new technologies employing high-speed computers coupled with advanced telecommunications technologies has not only resulted in relatively lower transaction costs but also promoted increasing intra- and inter-firm integration functions. Firms earn high profit margins not only through low wage and low skills production but also through fast delivery of customized products and services to customers. The scope advantage of small firms has been significantly enhanced by new technologies, be they manufacturers of batch orders or subcontractors to larger firms.

The book therefore presents preliminary evidence on the various ways of learning in firms in an Internet-based production environment but within a developing context characterized by skill deficiencies as well as weak institutional support. In short, the central research proposition in this book is this: to explore the determinants of the rate and types of ICT tools adopted by SMEs – coded as e-business in the country studies – in a developing context. In doing this we study the private and public institutions that compensate for the public goods shortcomings in these developing countries.

In what follows, we review the literature on the following set of issues:

1. Determinants of new technologies adoption
2. Learning, knowledge and innovation in development
3. Knowledge, skills and new technologies
4. The role of infrastructure in adopting ICTs
5. The Internet and the adoption of e-business technologies
6. Growth, employment and the adoption of e-business technologies

1.2 Determinants of new technologies adoption

ICTs have been applied across such diverse organizations and institutions as business establishments, non-profit organizations, educational institutions and governmental agencies. While the range and penetration of application of ICTs has evolved over the years, the rate of diffusion has been extremely rapid in some sectors. For instance, until the

early 1990s, the application of ICTs in educational institutions was limited mainly to complex computations in science, technology and mathematics and related departments. However, as the decade progressed, universities and academic institutions also adopted distributed computing, e-mail and open access to the Internet. The twenty-first century began with online access of databases and research output, and online learning. Similar developments have taken place with increasing complexity in the industrial application of ICTs across sectors.

In the 1980s, mainstream firms began to use in-house ICTs such as CAD/CAM and CAE, but through the 1990s, many of these same firms began to take advantage of the advances in ICTs and started using network technologies for intra-firm co-ordinating activities. Large corporations were able to connect distant production facilities to create greater networks and reduce transaction costs. During this period, firms developed and adopted several industry-specific ICT tools for this purpose. In the garments manufacturing sector, companies such as Gerber Garment Technology and Laser Lectra developed specific tools for marker making, fabric cutting and computerized embroidery. By the beginning of the twenty-first century, the adoption of ICTs for inter-firm commercial and non-commercial transactions was widespread.

While many manufacturing technologies have been industry-specific, business organizations and other institutions have applied networking technologies, including the Internet, on a general basis. Owing to the unprecedented developments in communication and Internet technology, new trajectories of network technologies have emerged, varying from the simplest forms, such as e-mail, to more complex forms, such as portal-based technologies. Although these technologies are not activity-, firm- or industry-specific, their adoption is influenced by firm- and industry-specific factors. Presently there is relatively widespread use of ICTs countries in all business activities by firms in developing, as well as developed.

In this book we examine the application of ICT tools within SMEs broadly as electronic commerce (e-commerce) and electronic business (e-business). The two differ substantially in content.

Before proceeding further, we therefore distinguish between e-commerce and e-business technologies. An OECD (2002) study examining the application of ICTs in commercial activities defines e-commerce as '… the sale or purchase of goods or services, whether between business, households, individuals, governments, and other public or private organisations, conducted over computer mediated networks. The goods and services are ordered over those networks, but the payment and the

ultimate delivery of the good or service may be conducted on or offline' (p. 89). This differs from e-business, a term that encompasses the application of ICTs in all business processes from office automation, production processes, co-ordination with other plants, customer relation management, and supply chain management to the management of distribution networks (Lal, 2004).

Broadly speaking, there are three modes of e-business transactions. These are offline, online and e-business using shared or individual portals. Offline e-business is enabled by electronic messaging systems, which are less effective than other forms of e-business tools. Offline e-business is normally done through e-mail systems while on-line e-business transactions take place with company web sites, although having a web site does not necessarily mean that an enterprise is able to process online e-business transactions. Web sites must be dynamic and should have online transaction facilities such as Active Server Pages (ASPs) that allow online transactions. The most effective way of doing e-business is through portals. Portals are essential additions in network technologies and fulfil an important role of aggregating content, services and information on the net. Broadly speaking, their function on the net is to mediate between users (buyers) and web content. This unique position enables portals to leverage marketing and referrals, as they are intermediaries between web users and companies.

Following the debate on the so-called productivity paradox in the early 1990s in developed countries and in the mid-1990s in developing countries, empirical studies of ICT impact showed the numerous benefits of ICT adoption. It has been demonstrated that the adoption of ICTs in general and e-business in particular leads to a reduction in co-ordination costs and promotes efficient electronic markets (Damaskopoulos and Evgeniou, 2003; Lee and Clark, 1997). Damaskopoulos and Evgeniou, in their study of East European and Cypriot SMEs, found that most of the sample firms (over 900) established their web sites to take advantage of cost reduction, to ease the search for new markets and to augment competitiveness. The study reported that 67 per cent of the sample firms in Poland and 86 per cent of those in Cyprus created their web sites for the reasons given above. The study concluded that '… e-business affects first the boundaries of the firm with the market in which it operates'.

Hodgkinson and McPhee (2002) examined the impact of the adoption by SMEs in Australia of web-enabled technologies on the export market development. A study by Teltscher (2002) deals with the fiscal implications of e-business, while Drew (2003) investigates the causes and consequences of the adoption of e-business by SMEs in the East of England.

Following an analysis of the total value of transactions conducted through electronic means and its implications for the fiscal policies of developing and developed countries, Teltscher (2002) observed that '… an increasing number of e-commerce businesses are small entrepreneurs …' and '… the fiscal impact of international e-commerce is likely to be felt more strongly in the developing countries….'. The findings of Drew (2003) suggest that SMEs are placing e-business at the centre of their technology strategy. The majority of the sample firms reported that the driving force behind e-business adoption has been opportunities for growth and the need to remain competitive. Hodgkinson and McPhee (2002) conclude that international networking by SMEs brought knowledge to the New South Wales regional exporting firms in Australia that facilitates intra-firm learning. The study further suggests that adoption of the Internet by SMEs is higher, albeit marginally (68.8 per cent), than by large firms (66.7 per cent).

In the context of developing countries, several studies (Moodley, 2002a, 2002b; Goldstein and O'Connor, 2002; Goldstein, 2002) have examined the adoption of e-business by manufacturing firms. Moodley (2002a) did not find sufficient evidence to support the argument that export-oriented apparel firms in South Africa gain more in adopting e-business due to its promise of improved market penetration and its direct link to international competitiveness. Moodley's (2002b) findings on the South African automobile industry are similar.

Goldstein and O'Connor (2002) summarized the findings of several studies and concludes '… as multinational corporations integrate the Internet into their cross-border business operations, firms from developing countries run the risk of exclusion from global value chains if they cannot establish electronic ties with their major business partners'. They also argued that, despite these general remarks, an evident need persists for detailed sectoral analysis of the adoption of e-business. A case study of one of the top automobile firms (Fiat) by Goldstein (2002) suggests that while the company has been very successful in optimizing supply-chain management in Brazil, it has not been able to do so in India. The study further reveals that the use of the Internet by the company in India (Fiat India) has been limited to knowledge management, R&D and marketing. In other words ICTs are differentially adopted depending on context specificity.

1.3 Learning, knowledge and innovation in development

Technological learning is the way organizations, such as the sample firms, accumulate technological capability (Malerba, 1992). Technological

capability is the knowledge, skill and experience necessary for firms to produce, innovate and organize marketing functions (Lall and Wignaraja, 1998; Ernst et al., 1998). Much of the technological knowledge required by small and medium firms in the early stages of development in developing nations is incremental and can often be acquired through what is described as 'elementary learning' (Lall, 1982), although there are exceptions within firms that have moved up in the supply chain. As firms climb the ladder of manufacturing complexity, the types of knowledge they require, the nature of their organization and the forms of institution to support them become increasingly complex. In the past decade, we have come to know much more about the nature of learning and capability acquisition in firms, and in what follows we provide a brief overview.

First, learning in firms is a major source of incremental technical change, and as such a firm is a learning organization, and through the knowledge it accumulates, it continually transforms its knowledge assets to foster higher orders of operation (Lundvall et al., 2002; Malerba, 1992).

Second, following from above, a firm is characterized by a certain level of technical and organizational knowledge base. Third, a firm draws upon a wide variety of knowledge sources (suppliers, subcontractors, machinery suppliers) that may be within its locale or, often, outside the national boundary (Lundvall, 1988; Von Hippel, 1988).

Fourth, there are different modes of learning, of which learning by doing and learning through research and development (R&D) are only some of these sources. Learning by doing is by definition a costless, effortless process, which does not often lead to innovation. Learning efforts cannot lead to dynamic productivity gains without explicit investments that alter the technical and organizational assets of the firm.

Fifth, learning processes are linked to specific sources of technological and productive knowledge such as apprenticeship, equipment manufacturing and others. Sixth, learning does not take place in a vacuum and firms do not innovate in isolation. External actors with which firms interact are crucial to learning in firms. The sources of external knowledge by which firms internalize new capabilities range from equipment suppliers and input suppliers to universities, to research institutes, while the role of private business associations, as suppliers of knowledge, has become crucial. Learning processes are linked to the trajectories of incremental technical change through the accumulated stocks of knowledge in firms (Malerba, 1992). In other words, the direction of technical change is related to the types of learning process. The different types of learning identified in the literature are learning by doing

(Arrow, 1962), learning by using (Rosenberg, 1982), learning by searching and R&D (Dosi et al., 1988), learning by interacting (Lundvall, 1988; Von Hippel, 1988), learning by operating (Teubal, 1987; Scott-Kemmis and Bell, 1988), by changing (Katz and Ablin, 1987), system performance feedback (Bell et al., 1988), by searching and training (Dahlman and Fonseca, 1987) and, finally, by hiring (Katz and Ablin, 1987).

1.4 Knowledge, skills and new technologies

For a number of developed and developing countries, empirical literature shows evidence of continuous development of skilled workers, particularly those with tertiary education, over time. However, contrary to the conventional wisdom, underpinned by the demand and supply argument that wage inequality will be attenuated by an increase of skilled workers, the wage inequality between skilled and unskilled workers seems to be growing (Piva et al., 2003). This assumption draws on historical evidence dating from the Industrial Revolution when machines and low-skilled labour replaced the artisan. Underlying this change is the emergence, diffusion and use of knowledge, particularly scientific and technological knowledge that has reached its full manifestation in the new technologies of ICTs and biotechnology.

The form (that is, digitally coded information), content and the way we use different forms of technological knowledge have been transformed by rapid changes brought about by new technologies, while the mechanisms of skills transfer have been altered significantly by advances in microelectronics. The new competition (Best, 1990) as well as the changes in the economic context, particularly the liberal regimes of trade and production, are equally significant factors (Lundvall and Johnson, 1994; Johnson et al., 2002; Ducatel, 1998). There is renewed debate on the most appropriate mix of skills and the most important sources of knowledge accumulation in a new knowledge-driven economic context. Discussions are likely to continue on how to assign relative weights to formal and non-formal knowledge in firms, and the underlying conceptual dichotomy of tacit and codified knowledge.

Despite the burgeoning empirical evidence from the highly advanced countries, we are far from a full understanding of the most important determinants of the 'skill bias effect' often associated with both technological and organizational changes. According to the notion of 'skill bias effect', the rising skill content of the labour force is due to the accelerating rate of technological change, wherein technological change induces the demand for better educated and skilled workforce (Arrow,

1962; Nelson and Phelps, 1996).[4] Sectors that experience rapid technological progress would be inclined to hire workers who are more educated because this group has far less need for training in basic skills and constitutes a ready innovation asset within firms. The corollary is that technological change will in turn stimulate the demand for more knowledge-intensive and skilled labour. There is a preponderance of evidence of a positive association between the rate of technological progress and the demand for an educated workforce. Berman et al. (1994), working at the sectoral level, found positive correlation between R&D and skilled labour in the United States. Bartel and Lichtenberg (1987) also showed, using industry level data, that manufacturing industries in the 1960–80 period exhibited greater relative demand for educated workforce in sectors with newer vintages of capital.

In addition to the technology-induced skill effect, organizational change also seems to underlie the changing skill composition of firms. Introducing ICTs, for example, tends to change the ways decisions are made within organizations by 'flattening' hierarchies and promoting greater involvement of the workers in management (Caroli, 2001). Facilitation of greater interaction as well as information exchange at the factory level would tend to promote worker productivity. However, while the evidence is mixed regarding the productivity-enhancing impact of ICTs, there is greater evidence of the nexus of new technologies and the emergence of new forms of organization[5] (Brynjolfsson and Hitt, 1998). What this implies is that firms have to manage technological and organizational changes simultaneously, putting a demand on the resources required for technical, skill and organizational upgrading. As Guellec (1996) observed, 'Human capital and technology are two faces of the same coin, two inseparable aspects of knowledge accumulation. To some extent, the same can be said for physical capital. Accumulation of these factors goes hand in hand with innovation: one does not accumulate billion dollars of wheelbarrows or train millions of people as stonecutters. Only the appearance of new devices makes it worthwhile to invest and train.'

Developing countries are not insulated from, and indeed have much more to lose if they do not engage in, the debate to find ways to survive in the new environment of rapid technological and organizational changes. There are two reasons for this. The first is that all societies, regardless of their level of development, need to process and use knowledge. As Metcalfe (2003) observes, 'Every economy, always and everywhere, is a knowledge economy; for social systems and economies as social systems, could not be arranged otherwise.' The second reason

stems from the well debated notion that the growth, validation and transfer of knowledge is a socially distributed process mediated by institutions (Lundvall and Johnson, 1994; Metcalfe, 2003; Ducatel, 1998). However, institutions of knowledge in developing Africa are weak, and in most cases absent. Small firms often lack the resources for innovation and tend instead to concentrate on achieving the nominal production capacity with which daily routine is ordinarily concerned.

In transforming codified global digital knowledge to local use, only a portion can be transferred by formal technology transfer mechanisms; the rest often requires a long heuristic process of imitation, reverse engineering, learning by doing and apprenticeship. Stiglitz (1999) termed these processes of learning 'horizontal methods of knowledge transfer', while the formal, codified storable mode is called 'vertical transfer'. These largely practical informal methods can take several forms.[6] Despite the increasing propensity to codify technical functions, tacit knowledge remains an important component not only in the context of traditional sectors and small firms, but also as a necessary cognitive basis for interpreting codified knowledge, including digital and mathematical functions. In contrast, formal learning is characterized by five distinct characteristics: it has (1) a prescribed framework; (2) an organized learning package or events; (3) the presence of a designated teacher or trainer; (4) the award of a qualification or credit; and (5) the external specification of outcomes (Eraut, 2000). However, building institutions for formal knowledge accumulation is costly and time consuming, and poor countries often lack the resources to sustain them.

The clear importance of tacit and codified knowledge highlights the dichotomy of formal and non-formal institutions. As Stiglitz (1999) argued, developing countries need to formulate effective ways to promote *local knowledge institutions* because evidently 'the overwhelming variety and complexity of human societies requires the localization of knowledge'. There is a clear distinction between global public goods and local knowledge, and for this reason every society should be active in strengthening local knowledge institutions to drive the local learning process.

1.5 The role of infrastructure in adopting new technologies

Physical infrastructure comprises energy supply, water, telecommunication and transport systems (roads, railways, airfreight etc.). Notably, physical infrastructure tends to function poorly in developing countries leading in many instances to investment in alternative facilities such as

boreholes and electrical power generating sets. This tends to raise the production cost as well as the price of goods and services, thereby depressing demand. A rise in the quality of infrastructure could be productivity enhancing; where such a change is negative or cost escalating, either the quality deteriorates or prices of utilities rise.

Technological infrastructure proxies with ICT infrastructure, which may be divided broadly into three components: telecommunications, computing and connectivity infrastructure.

Connectivity infrastructure has four components: (1) the aggregate bandwidth of the domestic backbone(s), (2) the aggregate bandwidth of the international IP links, (3) the number and type of interconnection exchanges and (4) the type and sophistication of local access methods. Internet penetration, defined as pervasiveness, represents the number of users per capita, which proxies either the Internet hosts counts or individual users. The pervasiveness of Internet use is a function of among others, access to services, perceived value to users acceptable costs to users, and ease of usage, which depend crucially on content language. Finally, the structure of the Internet service providers (ISPs) market is an important factor influencing access. The presence of ISPs, and the institutional regimes in which they operate, is also important to market competitiveness, and as such it involves a cost to end users. For instance, Internet diffusion may be slow where state policies create barriers to ISP entry, or where cultural limitation leads to persistent disparity between girls' and boys' education, or where security concerns create a regime hostile to competition. Access at the individual level is achieved using modems at early stages of development, while more sophisticated infrastructure, such as leased lines, is used in later stages of development.

National, local and regional telecommunications infrastructure include server connectors, local loop telecommunication lines, internodal connections and switching systems, among others, and determine the cost and quality of access. Users in high-bandwidth telecommunications environment are likely to have access to lower cost connections. Most developing countries face capacity constraints, largely as a result of thin bandwidth and frequent power outages. At the very basic level, developing countries exhibit highly differentiated access to telephone and electricity services, which in developed countries are taken as a given. The quality of the physical and technological infrastructure is important for the simple reason that information, coded in files, travel through a series of linked nodes within the ICT network.

Table 1.1 Distribution of mean value of variables by the intensity of Internet use (2000)

Variables	Intensity of Internet use		*F*-statistics	Level of significance
	Low	High		
EDU	2.604 (2.33)	4.23 (4.33)	2.11	0.155
GDP	381.61 (334.57)	1452.2 (1642.9)	8.14	0.007
IH	0.18 (0.22)	6.51 (12.35)	5.28	0.028
ITI	0.02 (0.34)	6.36 (10.40)	5.98	0.020
IU	10.71 (6.48)	130.83 (199.67)	7.64	0.009
PCDEN	2.94 (2.39)	21.01 (26.72)	8.19	0.007
TELEDEN	5.44 (3.07)	46.06 (66.79)	6.29	0.018

Note: Figures in parenthesis are standard deviations. EDU, education; GDP, gross domestic products per capita in USD at 1995 level; IH, internet hosts per 10,000 persons; IU, internet users per 1,000 persons; PCDEN, personal computers per 1,000 persons; TELEDEN, telephone lines per 1,000 persons; and ITI, investment in telecommunications infrastructure.

The slowest link in the network node becomes the rate-determining step and thereby defines the overall speed of data transmission (Dholakia, 1997).[7]

In a separate study, Oyelaran-Oyeyinka and Lal (2005) showed the relationship of the different infrastructure variables to the process of wealth creation. Table 1.1 shows an Internet user index (IUI) that we relate to the technological infrastructure variables, namely telephone, PCs and Internet host. The aim is to demonstrate the strong correlations of the three infrastructure capitals, although the direction of causality is not always easy to establish.

The variables were analysed by classifying all Sub-Sahara African countries based on their relative density of Internet users. In this case, the groups were also categorized on the basis of the median value of the density of Internet users, that is, 19 persons per 10,000 inhabitants. Descriptive statistics of variables, along with significance of group mean differences are presented.

The table shows the EDU, measured as the ratio of enrolment at the tertiary level of education to the total eligible persons, does not differ significantly between the two groups. The table also shows the high significance level of many of the variables. For instance, PC density and income level of countries in both the groups differ significantly (1 per cent). The significance level of the remaining variables, that is, IH, ITI and TELEDEN, is at the 5 per cent level. However, it is difficult to draw any conclusive inference from the table for two reasons: first, the statistics presented in the table are based on the data for only one year and,

second, the results are based on univariate tests that exclude the interaction of other variables. Therefore, we explored the relationship between Internet users and the most significant variables in the univariate analysis. The trends are presented in Figures 1.1–1.3.

Figure 1.1 presents the relationship between the density of Internet users and the economic wealth of Sub-Sahara African countries. The figure shows that per capita GDP is an important determinant of Internet diffusion. The R^2 of a trend line between Internet users and GDP is 0.62, which indicates a strong explanatory power of GDP in influencing use of the Internet. Sixty-two per cent of the variance of the dependent variable is explained by GDP per capita. This confirms similar findings cited earlier.

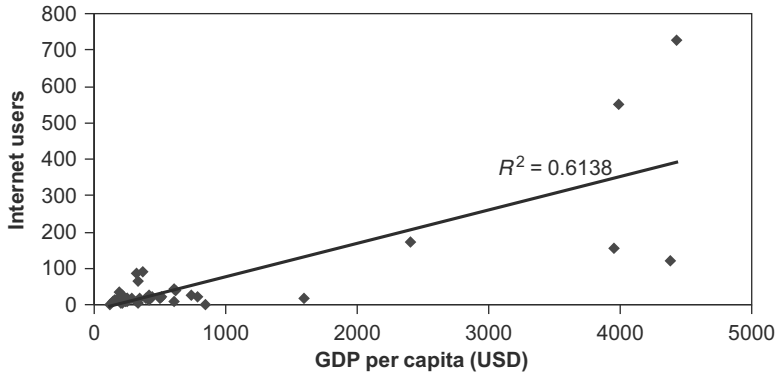

Figure 1.1 Internet users and GDP per capita in USD (2000)

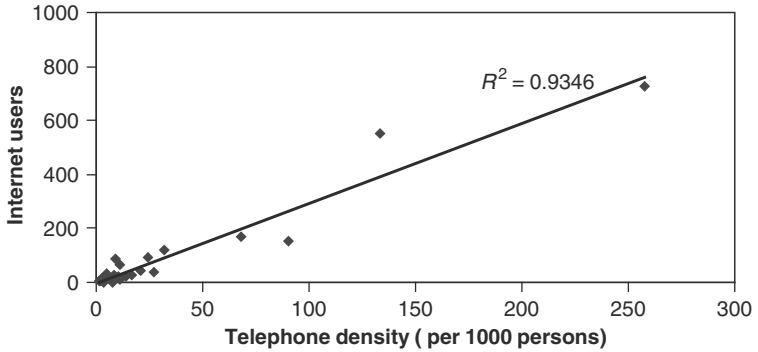

Figure 1.2 Internet users and telephone density (2000)

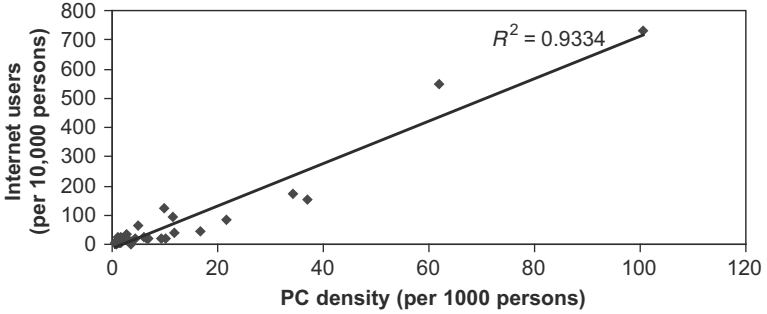

Figure 1.3 Internet users and PC density (2000)

Similarly, Figure 1.2 presents the relationship between use of the Internet and last mile connectivity in Sub-Sahara African countries. Last mile connectivity is the connection between end-user and the server of the Internet service provider, which is the telephone line in most of the Sub-Sahara African countries. The value of R^2 of the trend line between these variables is 0.93, which is very high. In other words, 93 per cent of the variance of the dependent variable is explained by telephone density.

We conclude from Figure 1.3 that telephone density is more important than GDP in explaining the variation of Internet diffusion in the sample countries when they are analysed separately in a single equation framework. However, their relative importance might change in the multivariate model, which we carried out in a paper (Oyelaran-Oyeyinka and Lal, 2006) cited earlier.

The mean values of PC density also emerged as significantly different in low- and high-Internet using countries. The relationship between these variables, depicted in Figure 1.3, therefore validates the statistics presented in Table 1.1. The very high R^2 (0.93) of the trend line between these variables suggests that the explanatory of PC density is also very high.

The graphs shown in Figures 1.1, 1.2 and 1.3 are based on data for the year 2000. The trend depicted in these figures may not remain the same once the data are analysed for other years. To obtain a more robust relationship between the diffusion of the Internet and other macro variables, the data were analysed using the simultaneous equation approach.

The following paragraphs summarize the output of the analysis carried out in a simultaneous equation framework.[8] The parameters of the model were estimated using pooled data, as well as each year separately (1995–2000). The model consists of three equations. They are labelled

as Internet diffusion, infrastructure and communication network equations and represent the spectrum of our three infrastructure capitals.

The Internet diffusion equation identifies the factors expected to influence Internet diffusion directly. The second equation examines the role of existing telephone density and per capita investment on telecommunication infrastructure, while the third equation investigates the role of economic wealth and the density of Internet users in influencing telephone density.

The findings of the study suggest that the density of Internet hosts and personal computers significantly influence Internet diffusion and confirm earlier univariate analysis. The emergence of these variables as important determinants is not surprising because the possession of a computer is a necessary condition for Internet access. A large number of Internet hosts facilitates more efficient and effective use of the Internet. The results support the findings of Oyelaran-Oyeyinka (2002) that concluded that ease of accessibility to the Internet was a significant factor in its diffusion in Nigerian universities.

The results also show that a lag of even one year's investment in telecommunications infrastructure as well as the existing telephone density are important determinants of the density of Internet hosts that in turn influences use of the Internet. These findings are not surprising and support the findings of earlier studies (Hargittai, 1999; Kelly and Petrazzini, 1997). Given the gestation period of these technologies, a one-year lag, rather than the current value of investment in the telecommunications network, can emerge as significant. Despite Kiiski and Pohjola (2002) having used an alternative measurement of last mile connectivity, their results are akin to that of this study with regard to the importance of telephone density in influencing Internet use.

The study captures the significant role played by economic wealth in stimulating the diffusion of the Internet. Similar results have been found by almost all the studies that examined the predictive role of GDP per capita. The role of economic wealth becomes more relevant in the case of ICTs because governments need significant investment capital for a reliable and efficient communications network in order to experience a faster diffusion of these technologies. National and global communications networks are not possible without sufficient economic wealth.

1.6 The internet and the adoption of e-business technologies

The current literature argues that the adoption of ICTs leads to significant reductions in co-ordination costs and to efficiency gains in electronic

markets (Malone et al., 1987; Lee and Clark, 1997). Almost every nation searched for alternatives to paper-based methods of information communication and storage in the last quarter of the twentieth century. The Internet has arguably been at the forefront of recent development in the application of ICTs and is possibly the most pervasive of the ICTs. The use of the Internet cuts across application fields such as business, education and governance as well as geographical boundaries. Its wide application has attracted the attention of social scientists, who have examined the causes and consequences of Internet adoption. A study by Kiiski and Pohjola (2002) analysed the diffusion of the Internet in OECD countries and using data for 1995–2000. The authors found that GDP per capita and access cost were the main factors that influenced Internet diffusion in this group. A study of 47 developing countries (Biliamoune, 2002) used Internet hosts, Internet users, personal computers and mobile phones as indicators of ICTs diffusion and found that income levels and trade policies were the main determinants of the diffusion of ICT.

A comparative study of the diffusion of Internet use in China and India by Press et al. (2003) identified six dimensions that led to the differential growth of the Internet in these countries: pervasiveness, geographical dispersion, organizational infrastructure, connectivity infrastructure, sectoral absorption and sophistication of use. Broadly categorized in these six dimensions and using data from various years as indicators, the authors identified comparative advantages in 1999 and 2002 of aspects such as Internet users and hosts; its applications in education, government and health; availability of national and international bandwidth; telecommunications competition; international gateway competition; and co-ordinating organizations. They conclude that although India has significant advantages in the use of the Internet in governance, telecommunications competition and international gateway competition during 1999–2000, China continues to have a substantial lead in the diffusion of the Internet.

1.7 Growth, employment and the adoption of e-business

Concern about the employment effects of ICTs has been apparent since the early stage in the development of ICTs and their adoption in various economic activities. While many view ICTs as a major cause of mass unemployment, others believe that ICTs create many new jobs and give rise to new industries and services (Talero and Gaudette, 1995). In the early stages of ICT adoption, there was considerable apprehension that the adoption of these technologies might result in reduced levels of employment, particularly of semi-skilled or unskilled workers. This view

underlined the programmability feature of ICTs and their capability in handling multiple tasks with a single ICT tool. Therefore, the perception emerged that the adoption of ICTs had a negative effect on employment. It is still believed that ICT tools replace certain categories of workers and lead to a significant rise in unemployment levels. The reasoning has some validity, particularly at the enterprise level with respect to existing manufacturing processes.

The adoption of ICTs in labour-intensive activities is expected to result in the displacement of labour, while creating a few jobs for the skilled workers needed to maintain the ICT tools. The adoption of ICTs may be labour-neutral if there is a possibility of market expansion for existing products or the possibility of creation of markets for new products manufactured on the same assembly lines due to the extensive use of ICTs. This may apply at the enterprise level, but its application at higher levels of aggregation is likely to be even greater. In the presence of possible market expansion, the adoption of ICTs could lead to creation of employment for skilled workers; if the market expands fast enough, there may not be a loss of jobs for unskilled workers. However, to use ICT tools effectively, firms may need to effect organizational changes and workers may require training to upgrade their skills. The findings of several studies that deal with employment aspects of ICTs are presented below.

Rada (1982) and Kuwahara (1984) found that the adoption of IT at the enterprise level leads to new jobs in some production processes and a loss of positions in other activities. The authors also found evidence of the emergence of firms with new activities, which usually fall within the sector, but outside the existing enterprises. For instance, several new consultancy firms have emerged in the garments sector to provide technical input and technological support to garments manufacturing firms. Although they provide consultancy services in other manufacturing technologies in the garments sector, their main activities are to provide training and consultancy services in the new ICT-based technologies.

Freeman and Soete (1985) found no evidence of an adverse relationship between employment and the adoption of IT. Their conclusions are based on several other studies (Leontief and Duchin, 1983; Kuwahara, 1984; Lawrence, 1984) carried out in developed countries (USA, Canada and Japan). The study by Leontief and Duchin (1983) is a very comprehensive one, analysing 89 individual sectors comprising almost the entire industrial spectrum of the US economy. They conclude that there will be no overall labour surplus as a result of the adoption of IT at the industry level, even though employment in some individual enterprises may suffer.

However, the study predicted that the structure of the labour force, in terms of skills and sectoral distribution, might have to undergo some fundamental changes. A study by Lawrence (1984) finds a positive correlation between the industrial adoption of IT and employment growth in Japan.

Peitchinis (1984) studied the employment effects of the introduction of computer equipment and office automation in a number of Canadian manufacturing sectors, ranging from food to oil companies. The author rejected the prediction of mass unemployment as a result of IT adoption. On the contrary, his case studies, based on firm-level data, suggest that the employment effects of IT adoption have generally been positive. The results were found to be more relevant for firms where the demand for their products was not saturated and there was a possibility of production capacity expansion. Firms could generate employment by increasing production capacity and by the adoption of IT. The author, however, observed that in mature industries there could be employment displacement because of IT adoption. Although the firms covered by Peitchinis were engaged in manufacturing goods, the study concentrated mainly on the introduction of computer equipment in office automation. Therefore, the results cannot be interpreted as representative effects of IT adoption in manufacturing.

A study by Kuwahara (1984) emphasizes the positive employment-generating effects of a range of new technologies in the Japanese economy. Although these new technologies include biotechnology and aerospace, the main emphasis is on IT. The study views microelectronics-based technologies (technologies used to manufacture hardware of information systems, communications equipment, audio/visual devices and other electronic products) and IT as having creative multiplier effects in other industries and services. The study presents detailed estimates of job creation effects in high-technology industries in Japan, and presents the estimates categorized into various skills levels. The findings suggest that engineers are likely to be in greater demand than non-technical workers in high-technology industries. Several other studies (Rada, 1982; James, 1994; Rahim and Pennings, 1987) proposed the possibility of structural change in employment. Rada (1982) found evidence of a reduction of jobs at the supervisory level. At the same time, IT tools require a highly skilled workforce for the implementation and use of microelectronic-based systems (Ayres, 1991; James, 1994). Developing countries (DCs) have experienced similar employment effects of IT. Acero (1995) reported changes in employment structure in a study of the Brazilian textile industry. She found that industrial automation and new organizational technologies are seen as contributing to higher

employment levels in the technical and managerial category, while the number of occupational categories and labour-intensive tasks decreases with the introduction of IT. Sim and Yong (1995) found similar results in their study of the Malaysian telecommunications industry.

Doms et al. (1997) examined the correlation between the ratio of non-production to production workers and the use of advanced technology. The authors found a positive correlation between two variables, consistent with the complementarity of skill intensity and advanced technology use. A study of 402 plants in Britain by Kramarz (1998) suggests that the introduction of computers in plants is associated with an increase in the share of white-collar workers at the expense of unskilled workers. Card et al. (1997) investigated the effect of computer use on the employment rates of various age and education groups. Based on their knowledge of the institutional environment of the three countries (USA, Canada, France), they expected the greatest negative impact of IT on employment to be in France. Their hypothesis was that if a similar negative demand shock affects less skilled workers in all three countries, then given the labour market flexibility in the US, the shock should result primarily in a decline in the relative wages of less skilled workers. In France, where labour markets are relatively inflexible, the shock should largely result in a decline in the relative employment of less skilled workers. However, the results do not seem to show this pattern. In the US, results show that groups, categorized by age and education, that use computers most intensively record an increase in group-employment rates. In France (female workers) and Canada, there is no significant relationship between computer use and employment. The US results are based on data extracted from Current Population Survey (CPS) of 1979 and 1989, while Labour Force Survey (conducted in 1982 and 1989) data were used for France. The data for the Canadian sample come from the Survey of Work History (1981) and Labour Market Activity Survey (1988).

1.8 Outline of the chapters

Chapter 1 introduces the objective of the book and reviews the empirical literature on the different factors that influence how SMEs adopt new technologies. Chapter 2 presents the methodological framework that includes the process of sample selection and the characteristics of the various industrial clusters.

Chapter 3 examines the impact of industry-specific factors on the intensity of ICT adoption in business applications. Adoption of a new

technology is influenced not only by industry-specific factors, but also by the level of the country's economic development. Nigeria, Uganda and India are at different levels of technological and economic development and the thrust of policies are therefore different in respect of e-business adoption. The data we collected indeed reflect how significantly their need and capacity for technological absorption differ, and necessarily, we analyse the data for each country separately. Furthermore, since the intensity of e-business tools adoption differs significantly in each country, we could not adopt a uniform categorization of e-business tools across all the three countries. Lastly, while we have wide sectoral variations, this provides a basis for a rich comparative analysis across countries in this chapter.

Most of the studies analysing the causes and consequences of e-business adoption have selected firms controlled for their size-of-operation and product mix. Given the paucity of such studies in developing countries, we analysed the factors that influence the adoption of internal e-business technologies in Chapter 4. What constitutes internal and external e-business technologies is discussed fully in the chapter. The chapter classifies clusters of firms on the basis of choice of technology, identifies factors that result in the adoption of a particular technology and analyses these factors within a multivariate econometric framework. The algorithm requires information on the number of clusters and based on the known characteristics, computes a composite index. The criteria for convergence are such that the variance of the composite index within a cluster is minimal and the variance between the clusters is maximal. We found considerable differences in the types and levels of technologies utilized in firms and across countries even after controlling for sectoral differences.

In Chapter 5, we present evidence of learning processes and investment at the enterprise level. We advance three main theses. First, that there is clear evidence of increasing complexity in the adoption and use of ICTs among developing country firms. Second, that climbing the technological ladder requires skills upgrading through explicit learning of new technologies, and for this reason the rate of ICT adoption in developing nations has been highly differentiated. Third, that firm performance is highly associated with learning capabilities, levels of technology, and a host of firm-level knowledge, skills and experience. In a novel attempt, the chapter statistically tests different learning mechanisms using both Ordinary Least Square (OLS) and bivariate distribution of firms based on the technological trajectories that firms follow.

The main objective of Chapter 6 is to identify and analyse supply side factors that support the adoption of e-business by SMEs. They are made up

of physical and technological infrastructure available to SMEs. While the intensity of adoption of e-business tools differs considerably in each country, the nature of support shows a common strand. Institutional structures are meant to support firms using e-business technologies in production as well as in other activities such as marketing, co-ordination and after sales. The tools employed in production processes comprise mainly computer-aided design/computer-aided manufacturing (CAD/CAM), computer-integrated manufacturing (CIM), flexible manufacturing systems (FMS) and computerized numerically controlled (CNC) machine tools. Firms use e-mail, Internet and web-enabled and portal-based technologies for transaction processing and co-ordination of activities. Almost all the sample firms in India were using office automation technologies such as management information systems (MIS) and local area networks (LAN).

Chapter 7 identifies four important factors identified in our study that tend to be closely associated with the adoption of e-business: the potential business activities in which e-business technologies can be adopted; the availability of reliable and affordable ICT infrastructure; the potential gains expected from e-business and the impediments associated with e-business in a developing context. It is difficult to cover all these aspects in one study; we therefore focus on a limited number of objectives in this chapter:

1. factors that discriminate advanced users of e-business technologies from others;
2. the impact that the perception of management has on the adoption of new technologies;
3. the impact of the competitive environment on the diffusion of e-business technologies;
4. the role of the institutional environment in the growth of e-business; and
5. the role of collective actions in the diffusion of e-business technologies.

Chapter 8 addresses an issue of enormous importance that has, however, received scant attention: the implication of adopting new technologies by SMEs in a labour surplus economy, such as India. The study examines the direct and indirect impacts on employment of the production and adoption of ICTs in India. The case of India is relevant because the country has made significant progress in global software production on the one hand and is facing serious unemployment problems on the other. A long-time data series is needed to examine meaningfully the impact of ICT adoption on employment; however, it is

extremely difficult to collect data on workforce[9] for a long period of time. Hence, we have used the case study method to address the issue of employment and new technology adoption in business organizations. Since the effect on employment is expected to be sharper in large firms, we have selected a number of top firms within the skill- as well as labour-intensive sectors. While investigating the effect on employment, we have also taken into consideration the employment generated by the production of e-business technologies. In this chapter we present case studies of high-performing firms in related subsectors, namely e-business technologies (that is, ICT sector), consumer electronics and the garments manufacturing industry.

Several studies have demonstrated the importance of technological differences in international trade. The studies suggest that non-price factors, such as product quality and product differentiation, exert a significant influence on international competitiveness. Chapter 9 documents our findings on how new technologies impact the export performance of SMEs. New technologies have been widely adopted by various types of firms engaged in the manufacturing and service sectors, in both developed and developing nations. The justification has been based on the perceived links between ICTs and gains in productivity, improvement in product quality and increased flexibility in manufacturing processes. This chapter addresses factors that determine the adoption of ICTs using case studies of Indian firms, and in doing so we analyse the consequences of the use of e-business practices on firms' export competitiveness.

Our preliminary finding is that e-business fosters organizational innovation, enabling firms to enter new and changing markets. Through e-business, companies reshape their market presence and the manner in which customers buy their products and services. Through the use of ICTs, firms can reach new customers more efficiently and effectively, thereby transforming the mode of exchange of goods, services, information and knowledge.

Chapter 10 draws conclusions and policy implications, as well as signals directions for future studies.

2
Methodological Framework for Studying SME Clusters

2.1 Methodology

There are several dimensions to explaining the rate and nature of ICT diffusion among SMEs in developing countries. For one, there is the role of the institutional environment that is different across countries but uniformly underdeveloped compared to the more industrialized context. Second, there is the intervening role of clustering that creates a 'network' effect within the geographic space of industrial clusters. Again, SMEs are a highly heterogeneous group with different size structures and trade orientations. For instance, while relatively small firms characterized by financial and technical resource constraints rely mainly on the domestic market, medium to large firms with considerably higher technological competencies tend to venture into export markets.

Export dynamism requires competitive capabilities that go beyond low wage and low-cost strategies. Steady and sustained growth demands continuous accumulation of technological capabilities, and it is on this theoretical foundation that our hypotheses are based. Our hypothesis derives from the literature on learning and upgrading in traditional industries. It argues that firms that adopt e-business tools also have the propensity to acquire complementary capabilities; these firms will be owned by educated entrepreneurs and have a preponderance of fairly well-educated workers. Firms that tend to be laggards in adopting e-business technologies are unlikely to be competent in other areas of their core activities. However, this one reason does not explain fully why these firms cannot sustain their dynamism. A second proposition draws its inspiration from the literature on institutions (North, 1990; Edquist, 1997), which explains the performance of systems on the basis of the presence of dynamic institutions.

This book therefore tests these two broad propositions, using a survey of a large number of firms as well as specific and detailed case studies of selected firms. The research projects were conducted within the framework of institutions and institutional change. We combine the review and analysis of macroeconomic data on different sectors in three countries: Nigeria, Uganda and India. The study uses data collected from industrial clusters in these developing countries for the purpose of understanding the characteristics and technological profile of small firms there. Given the different institutional contexts and varying levels of economic development, one of our objectives is to map and compare how different industrial structures impact the adoption of new technologies such as ICTs. Although promotional measures for small firms have been initiated by almost every country, the types of measures taken by the countries covered in this study are relatively similar although implemented to different degrees. A striking example is the popularity of industrial clusters and clustering policies. The inclusion of India in this study was considered vital for two reasons. First, India has been able to maintain its share of traditional sector products such as garments in international trade while most African countries have not. Second, the country has made its presence felt in modern sectors such as computer software. These developments may be closely inter-related, suggesting that the presence of a strong software industry in the country might have influenced the adoption of new technologies led by ICTs. On the other hand, although Nigeria has a relatively large pool of engineers, its high-tech sector has not been able to contribute significantly to the economic growth of the country. Uganda was considered important because it is one of the African countries that have tried to promote small firms very aggressively. Given the characteristics of these countries, a comparison of the conduct and performance of small firms is expected to reveal other factors that have led to observed performance of these countries. Although the promotion of industrial clusters policy has not been uniformly successful in developing countries, it has been pursued by almost every country. Industrial clusters in India were developed with proper technological infrastructure aimed at creating a supportive environment for faster industrial development; the same cannot be ascribed to the two African countries. Although the objectives for the creation of industrial clusters were the same, the countries have followed different strategies. For this reason we discuss briefly in this chapter the origin and technological infrastructure of industrial clusters created in each country.

2.2 Study sample and sampling

The study uses data collected from industrial clusters of Nigeria, Uganda and India for the purpose of understanding how enterprises adopt ICTs and to what use e-business tools are applied in firms' processes of learning and capability-building efforts. The Indian clusters were purposely developed with proper technological infrastructure aimed at creating a supportive environment for faster industrial development. In the two African countries the clusters emerged organically and are not as well developed as the Indian clusters. Although the objectives of studying the clusters were the same, the origin of the clusters, in these countries have followed different developmental trajectories. It is therefore important to discuss briefly the genesis and available technological infrastructure of industrial clusters in each country.

2.3 Origin and characteristics of the Indian clusters

Two industrial clusters were examined in India, Okhla and New Okhla industrial development authority (NOIDA); both clusters are located in and around Delhi. The industrial development of Okhla dates to the 1950s, and it was the first town in the national capital region adopted by the government for the development of SMEs. Initially, entrepreneurs were encouraged to start the business of their choice and were allotted industrial plots of 500 to 1000 square metres at very nominal charges for this purpose. The scheme was very successful, and as a result of growing technological capabilities, entrepreneurs ventured into export markets. With the move into the export market, it became necessary to provide export–import facilities in Okhla, and consequently the Ministry of Railways and the Container Corporation of India jointly established a special rail link between various ports and Okhla. The rail link prompted further growth, however, and by the early seventies, demand for land significantly increased land values, which restricted SME expansion. To address this problem, the Government of India (GOI), through the Delhi State Industrial Development Corporation (DSIDC), introduced the concept of Flatted Factories. DSIDC constructed multi-storied factories and each floor was sold to new entrepreneurs.

Despite these arrangements, the scarcity of available land continued to hamper GOI's ability to keep pace with industrial development. So, in the mid-seventies GOI decided to develop another industrial town near, but not within, the geographical boundary of Delhi. NOIDA and the subsequent NOIDA Export Processing Zone (NEPZ) were created in the late

seventies, and in a span of 20 years both were fully developed. NOIDA reshaped the industrial map of Okhla, which had been dominated by electrical and electronic goods and garments (leather and fabric) manufacturing firms. The vast majority of Okhla's electrical and electronic firms moved their manufacturing plants to NOIDA and NEPZ, although a few retained their registered offices at Okhla. Additionally, the owners of several electronics firms sold their factories to garment manufacturers at Okhla. Consequently, Okhla became one of the major clusters of garments manufacturing in India while NOIDA became a major electronic and electrical cluster. Therefore, for the purposes of this study, Okhla was selected to study the pattern of IT adoption in the garments industry while NOIDA and NEPZ were selected to study the pattern of IT adoption in the electrical and electronic goods industry.

In the last two decades, many car-manufacturing plants (including Maruti Suzuki in Gurgaon and Honda Siel Cars India Ltd near NOIDA) were established near Delhi. Subsequently, a large number of auto-components manufacturing firms emerged in NOIDA and in Udyog Vihar, another industrial cluster developed by Haryana, a neighbouring state to Delhi. Although auto-components manufacturing firms are uniformly distributed between NOIDA and Udyog Vihar, we chose to survey the auto-components manufacturing firms located in NOIDA due to its closer proximity to Delhi.

2.3.1 Sample size

The data were collected using a semi-structured questionnaire. We collected the following firm-level information: company history , balance sheet data, foreign collaboration, performance, technological profile, product profile, skill composition of workforce and the opinion of managing directors (MDs) about institutional support provided by local and central governments. Although we tried to collect time series data on the adoption of ICTs, the MDs (MDs) were not willing to devote the required time, and hence we could only get data for the financial year 2001–2. The samples were selected by the addresses of firms, which were taken from the directories published by the respective industrial associations. For example, the firms located in Okhla were selected from publication of Okhla Industrial Association while the firms located in NOIDA were selected from the NOIDA Entrepreneurs Association Directory.

The survey was conducted from May to September 2002. As Okhla is known as a centre for garments manufacturing enterprises, it was decided to collect data for the garments firms located there. All 109 garments

manufacturing firms located in this area were approached, with a response rate of 72 per cent (79 firms). Data for electrical and electronic goods manufacturing firms were collected from NOIDA, as that is where most of the modern sector firms are located. We approached all 104 electrical and electronic goods manufacturing firms located in NOIDA and received data from 80 firms, a response rate of 77 per cent. In the case of auto-components manufacturing firms, we secured data from 72 of the 97 automobile firms located in NOIDA, for a response rate of 74 per cent. In general, owner-managed[10] firms dominate SMEs in India, and all the sample firms reflect this trend.

2.3.2 Product profile of firms

The product profile of garments manufacturing firms is presented in Table 2.1. Although firms have not been classified by their export intensity, roughly 60 per cent of the sample garments manufacturing firms were export oriented. However, 13.9 per cent of firms have contracts with the public schools in Delhi to make school uniforms and operate strictly in the domestic market.

Table 2.1 also shows that the largest number of firms (22.79 per cent) make trousers and shorts for export markets. Although consumption of ready-made garments has increased in the domestic market, it is still negligible compared to total consumption. It was found that few firms (5.1 per cent) preferred to deal in cotton garments. The MDs of these firms reported that their clientele, although limited, is relatively stable, and so the firms are not affected by market uncertainties. Cotton garments manufacturing firms were mainly export-oriented units. Anecdotal evidence collected from manufacturers of cotton garments suggest that some elite customers prefer traditional cotton garments and are averse to the frequent changes in designs that characterize the

Table 2.1 Product profile of garments manufacturing enterprises

Products	**No. of enterprises**	**Percentage**
Shorts/trousers	18	22.79
Casuals	14	17.70
Gents wear	12	15.20
Formal wear	11	13.90
School uniforms	11	13.9
Ladies wear	7	8.90
Cotton garments	4	5.10
Embroidery	2	2.50
Total	79	100

international garments market. These firms find a stable and reliable market in this particular market niche.

Table 2.2 presents the product profile of automobile parts manufacturing firms in NOIDA. With few exceptions, almost all the automobile parts manufacturing firms located in NOIDA operate in the domestic market. A large number of firms were producing components for the automobile industry in general while others (23.61 per cent) were engaged in manufacturing parts for popular automobile companies like Yamaha in two-wheelers and Maruti in passenger cars. Although export intensity of automobile sample firms is low, a few firms, such as Minda, Huf Pvt. Ltd, and Motherson Sumi Systems, were exporting a large portion of their output to their foreign partners. The survey also revealed that several mechanical-parts production firms not only made parts such as clutch facing, brake lining, brake shoe and bright bars, they were also engaged in servicing and repairing jobs. Firms producing music systems for the automobile industry were not included in this sample because they were not manufacturing music systems exclusively for this industry. They are included in the third industry of the study, electrical and electronic goods manufacturing firms.

Table 2.2 Product profile of automobile enterprises

Core category	**Products**	**No. of enterprises**	**Percentage**
Batteries/lamp	Batteries, fuses, head Lamps, bulb holder and switches, dynamo, special bulbs	12	16.67
Clutch facing and brake lining	Clutch facing, brake lining, brake shoe, bright bars, filter, jacks parts, sheet metal parts	16	22.22
Mechanical	Auto-lock, door-handles, fuel tank, steel balls	10	13.89
Rubber products	Auto seat, car seat cover, filter, insulation, nylon belts, plastic products, PVC coated auto cables	11	15.28
Wire harnessing	Wire harnessing for car, buses, tractors, two-wheelers	7	8.33
Others	Air-conditioning, heat treatment, part of popular brands such as Yamaha, LML, Maruti	17	23.61
Total		72	100

Table 2.3 presents distribution of electrical and electronic goods manufacturing firms according to the type of goods manufactured. More than one-third of the sample firms manufacture TVs or supply components to TV manufacturing companies. Almost all the large TV manufacturing companies in India such as ONIDA, BPL and VIDEOCON, have their plants in NOIDA, which could explain the greater presence of TV components firms in the sample. Few components manufacturing firms were engaged in the production of integrated circuits (ICs), large scale integrated circuits (LSIs) and very large scale integrated circuits (VLSIs). Although telecommunication equipment firms represent only 11.25 per cent of the sample, they were very large firms employing more than 150 workers and one of them, Precision Electronic Ltd, was a highly diversified firm manufacturing goods from printed circuit board (PCBs) to communication devices at the same plant. The sample also includes the firms producing power, regulatory, and measurement devices.

Table 2.3 Product profile of electrical and electronic goods manufacturing enterprises

Core category	**Product**	**No. of enterprises**	**Percentage**
Television	Colour and black-and-white TVs	13	16.25
Audio systems	Amplifier and cassette players, audio cassettes, car audio systems, two-in-one, tape recorders, speakers, TV audio systems	14	17.50
Communication equipment	Dish-antenna, intercom systems, telecom cables, mobiles phones, telecom printed circuit boards, telephone systems	9	11.25
Power regulatory and measurement devices	Power inverter, uninterrupted power supply (UPS), switch mode power supply (SMPS), power testing devices, multimeters, energy meters, voltage stabilisers	13	16.25
Components	TV components, picture tubes, capacitors, telephone parts, deflection components, radio parts, heat sinks, filaments	16	20.00
Others	Calculators, electrical switch, exchange chard, photo voltaic power systems, solder bars, VCR, video projectors	15	18.75
Total		80	100

Table 2.4 presents the distribution of firms according to the MD's[11] education. The table shows that qualification of MDs is associated with technology intensiveness of firms. For instance, merely 10.13 per cent of MDs of traditional-sector firms had engineering or management degrees whereas in automobile and electronic sectors the percentages of MDs with these qualifications were 25 and 53.75 respectively. On the other hand, the percentage of graduate MDs shows a reverse trend.

2.4 Origin and characteristics of the Nigerian clusters

The survey of Nigerian firms was conducted from June to September 2001. We collected data from 105 firms through a semi-structured questionnaire. Nigerian sample firms predominantly belong to the engineering sector. The distribution of sample firms by the academic qualifications of owners is presented in Table 2.5. Unsurprisingly, owners of these firms were technically qualified persons. The table shows that 62.86 per cent of owners had either an engineering degree or a technical diploma.

2.4.1 Study area

The chapter covers industrial clusters located in two regions: namely southwestern Nigeria and eastern Nigeria (Table 2.6).

Cluster I: Ikeja, Isolo, Matori, and Ilupeju in the Lagos area and Sango Otta in Ogun State (all in the Southwest)

Table 2.4 Owner's qualification and degree of the adoption of e-business

Owner's qualification	**Industrial sectors**					
	Garments manufacturing firms		**Automobile components manufacturing firms**		**Electrical and electronic goods manufacturing firms**	
	Number	**Per cent**	**Number**	**Per cent**	**Number**	**Per cent**
MBA	7	8.86	7	9.72	13	16.25
BE	1	1.27	11	15.28	30	37.50
Post graduate/LLB and CA	21	26.58	24	33.33	19	23.75
Graduate	43	54.43	23	31.94	10	12.50
Under graduate	7	8.86	7	9.72	8	10.00
Total	79		72		80	

Table 2.5 Distribution of firms by owner's qualification

Owner's qualification	Number	Per cent
Engineering degree	38	36.19
Technical diploma	28	26.67
Other	12	11.43
No response	27	25.71
Total	105	100.0

Cluster II: Auto component firms in Nnewi and footwear and leather goods firms in Aba, both in eastern Nigeria.

Compared to other state capitals in the country, Lagos is highly industrialized, and the presence of government in terms of industrial and physical infrastructure is felt in the city. However, the high rate of influx of people to the area has exerted severe pressure on these infrastructural facilities.

2.4.2 Study design

The unit of analysis is the enterprise within the cluster; questions are directed to firms. There are three stages of information gathering:

Stage 1: Secondary information is collected, using official statistics as well as other local sources. Owing to time and resource constraints, it was not possible to conduct a survey of the entire cluster population. For this reason we relied on the census of SMEs in Nigeria conducted from the Manufacturers Association of Nigeria (MAN) and available information on the firms by the Nigerian Association of Small Scale Industries (NASSI) and the National Association of Small and Medium Enterprises (NASMEN) in obtaining relevant background information on firms in the clusters.

Stage 2: This is a survey of a stratified sample of enterprises within the clusters. To ensure that the different segments of the population are represented in the sample, the estimated 300 and 130 SMEs identified in clusters I and II respectively were divided into product groups of the MAN out of which 126 and 55 respectively were randomly selected in these areas using an appropriate sampling interval from each of the sectoral groupings.

The main survey instrument, structured questionnaires, sought to obtain data on both the enterprises and their horizontal and vertical relationships with other economic agents. Information on the background of the entrepreneurs, their workforce and the process by which they contribute to innovation was collected. The questionnaire was also

designed to find out how much of the firm's activity is carried out in-house and how much is subcontracted, with a view to determining how far and wide innovation collaboration is externalized. Other issues covered include the rate and direction of upgrading within the clusters, the influence of the socio-economic environment and the role of government in the development of the clusters.

Table 2.6 Major products of the SMEs within the clusters

Clusters	**Product group**	**Major products**
Ikeja	Chemicals and pharmaceuticals	Antibiotics, analgesics, anti-malarial, vitamins and blood tonic (of various brand names) and paints
	Fabricated metals	Aluminium profiles, agricultural machinery (for food processing and oil milling), drainage and pressure fittings, louvre frames, galvanised iron sheets, aluminium doors and windows
	Paper and paper products	Light packaging, labels, stationery and fax rolls
Isolo	Chemicals and Pharmaceuticals	Hair treatment chemicals (shampoos, setting lotion, styling gel and instant condi tioner hair relaxers,) hair curl, textile auxiliaries, analgesics, anti-malarial and skin care products
	Domestic and industrial plastic and rubber	Household plastics, general plastics and plastic water tanks
	Fabricated metals	Food processing machinery (grinders, pounded yam machinery, grain mills, cassava graters and presses), tricycles, foundry products (castings), straight and barbed wires and bearings
Matori	Chemicals and pharmaceuticals	Petroleum products (lubricants and greases), cassava-based adhesives, soap and detergent
	Food beverages and tobacco	Pure water, chocolate bar and cassava chips
	Textiles and wearing apparel	Sportswear, promotional wear, children's wear, men's wear, women's wear and women's hats

(*Continued*)

Table 2.6 (*Continued*)

Clusters	Product group	Major products
Ilupeju	Chemicals and pharmaceuticals	Soaps and detergent
	Domestic and industrial plastics and rubber	Shoes and shoe soles, polyethylene bags/sheets and footmats
	Paper and paper products, printing and publishing	Printing, office files and paper products (envelopes, exercise
	Fabricated metals	Iron rods, flat bars, office pins books, light packagings, labels) and staple pins
Otta	Chemicals and pharmaceuticals	Industrial chemicals (aluminium silicate, kaolin, industrial gases and printing ink)
	Domestic and industrial plastics and rubber	Imitation leather, household plastic products, polyethylene film, drinking straws, PVC sheets, floor carpets, plastics for plumbing work and tooth picks
	Fabricated metals	Aluminium roofing sheets, rooting accessories, drums and crown corks
Nnewi	Machinery and auto components	Brake linings, gaskets for motor cycles, roller chains for all engines, auto filters and power ropes
Aba	Footwear and leather goods	Men's shoes, women's shoes, bags and so on

The questionnaires were pre-tested on a proportion of enterprises and thereafter refined before they were administered. The questionnaire administration was done by trained research assistants under the supervision of the principal researcher.

2.5 Origin and characteristics of the Ugandan clusters

The survey was conducted from September –to October 2002 and covered 84 SMEs in the food and beverage sub-sector and the automobile parts or metal fabrication sub-sector in four Ugandan clusters: Kampala, Jinja, Mbale and Mbarara. The same questionnaire used for India and Nigeria was used to collect primary data from respondents. This information was complemented by informal interviews with SME entrepreneurs and Uganda Small Scale Industrialists Association (USSIA) representatives in

the different districts. The SMEs were selected using the same stratified random selection process used in the other surveys, based on the directory provided by USSIA.

2.5.1 Data sources

The districts were selected on the basis of the relative population of SMEs in the districts and the likelihood of finding satisfactory records for these establishments. Secondary sources include sector reports prepared by the National Council for Science and Technology and the USSIA.

The survey covered 43 firms in the food and beverage sub-sector and 41 in the automobile parts and metal fabrication sub-sector, making a total of 84 firms. The qualifications of the managers of the sampled enterprises are given in Table 2.7.

2.5.2 Basic descriptive

The level of education among entrepreneurs is relatively low; the majority of entrepreneurs in the food and beverage firms hold post-secondary diplomas while most managers in the automobile parts and metal fabrication sub-sector have only attained secondary school education. The lower qualification of entrepreneurs in the automobile parts and metal fabrication sub-sector can be attributed to the sub-sector's less technical nature and its reliance on learning by doing.

The study found that 86 per cent of enterprises in the food and beverage sub-sector were established after 1986, while 80 per cent of enterprises in the automobile parts and metal fabricating sub-sector were established after 1986 (Table 2.8). This trend can be attributed to the Economic Recovery Program launched in 1987 that emphasized the rehabilitation of the industrial sector that had previously been almost exclusively state-owned. The main theme of the programme was to encourage the private sector to invest in manufacturing and industry.

Table 2.7 Qualifications of entrepreneurs

Qualification attained	**Food and beverage (*n*=43)**	**Per cent**	**Automobile parts (*n*=41)**	**Per cent**
None	2	5	3	7
Primary	1	2	3	7
Secondary	12	28	12	29
Tertiary	none	none	none	none
Certificate	7	16	10	24
Diploma	16	37	11	27
Degree	5	12	2	5
Toal	43	100	41	100

Table 2.8 Year of establishment of firms

Year of establishment	**Food and beverage (*n*=43)**	**Per cent**	**Automobile parts (*n*=41)**	**Per cent**
Before 1986	6	14	8	20
After 1986	37	86	33	80

Table 2.9 Qualifications of regular employees

Qualification	**Food and beverage (*n*=43)**	**Per cent**	**Automobile parts (*n*=41)**	**Per cent**
Engineering graduate	3	1	5	2
Postgraduate	16	3	1	1
Diploma	32	5	20	9
Undergraduate	26	4	11	5
IT-trained	6	1	9	4
Others				
Certificate	118	19	31	14
Secondary	75	12	47	22
Primary	39	6	25	12
None	303	49	66	31
Total	618	100	215	100

In both sub-sectors, the greatest percentage of employees (49 per cent for food and beverage; 31 per cent for automobile parts and metal fabrication) had no qualifications at all and learned their skills on the jobs. These workers are mainly employed as apprentices and are often family members and/or relatives of the proprietors.

The employees with the highest education level were found in the food and beverage enterprises, Table 2.9. However, the automobile parts and metal fabrication sub-sector had a higher percentage (2 per cent) of engineering graduates, which reflects the engineering work typical of the sub-sector. This sub-sector also featured more IT-trained employees (4 per cent) in comparison to those in the food and beverage sub-sector (1 per cent).

As far as the product profile of the firms is concerned, food and beverage sector firms were engaged in producing maize flour, confectionaries, processed fruit juices, and milk and yogurt, while the product mix of automobile firms included fabricating metal doors, windows, gates and exhaust pipes. Few automobile firms were involved in car servicing and repair works.

3
Adoption of E-business and Industry-Specific Factors

Arguably ICTs are the most pervasive technologies developed in the last quarter of the twentieth century. The applications of ICTs cut across geographical and industrial boundaries and they have diffused far faster than what was envisaged in the early phases of development. Although ICTs now seem to be everywhere, we do not fully understand the dynamics of their application across industrial sectors. For instance, while ICTs might be used for peripheral activities in one sector, they might be the driver of core activities in another. In this chapter, we examine whether industry-specific factors have influenced the intensity of the adoption of ICTs in business applications. Our focus in this chapter is on the application of ICTs in core enterprise production, and for this reason we designate ICTs in business applications as e-business.

The adoption of any new technology is influenced not only by industry-specific factors but also by the level of that country's economic development. As the data for the three developing countries reflect how significantly their need and capacity for technological absorption differ, we have chosen to analyse the data for each country separately. Furthermore, as the intensity of e-business tools adoption differs significantly in each country, it is not possible to keep uniform categorization of e-business tools across all three countries.

For India we examine the pattern of e-business adoption in each sector (garments manufacturing, electrical and electronic goods manufacturing, and auto-components manufacturing) separately. Similarly, we will analyse the Ugandan data for auto-components and food and beverage firms separately. However, the Nigerian sample data will depict the pattern of e-business adoption in modern sectors only. This is because electronic goods manufacturing firms dominate the Nigerian sample.

3.1 Indian firms

For the data collected from India, firms in all three sectors were grouped into three categories: EB_eo, EB_p and EB_pu. Firms labelled as EB_eo use ICTs for electronic messaging systems and office automation while firms labelled EB_p use e-business tools in production processes along with electronic messaging systems and office automation tools. The firms labelled as EB_pu are those that use more advanced tools such as portals and URLs. The pattern of e-business adoption, in relation to the conduct and performance of firms, is discussed later in the chapter.

Table 3.1 presents the distribution of firms according to the intensity of the adoption of e-business and the academic qualification of managing directors or owners.

As reflected in Table 3.1, the academic qualification of the managing director has a direct bearing on the intensity of the adoption of new technology. This is true across all the industries. The majority of garments firms (68.97 per cent) that have adopted ICTs for e-mail and management information systems were being managed by holders of graduate or undergraduate degrees, whereas the majority of firms (61.53 per cent) that have adopted more advanced e-business tools, such as portals and URLs, are managed by holders of postgraduate degrees or MBAs.

In knowledge-intensive sectors, such as electrical and electronic goods manufacturing, the contrast is more evident. In this sector, over 87 per cent of the managing directors of EB_pu firms, those using portals and URLs, are engineering graduates, and many have additional management degrees. Only 47 per cent of similarly qualified managing directors used only e-mail and office automation systems. This contrast is strongest in the auto-components manufacturing sector. In this sector, EB_pu firms are managed exclusively by persons having MBA degrees, while holders of graduate or undergraduate degrees constitute 55 per cent of the managing directors of EB_eo firms (those that have adopted the lowest level of e-business tools). Table 3.1 shows that the level of the managing director's education directly corresponds with the level of advanced e-business tools used in all the sectors. Not surprisingly, this is more evident in knowledge-intensive sectors than labour-intensive sectors.

Table 3.2 presents the distribution of firms according to the use of e-business technologies in relation to the age of the managing directors. As the table demonstrates, this trend is not uniform across all the sectors, and we believe it has been influenced by the skill and knowledge intensity of the sectors.

Table 3.1 Owner's qualification and degree of the adoption of e-business

Owner's qualification	Intensity of e-business								
	Garments manufacturing firms			Auto- components manufacturing firms			Electrical and electronic goods manufacturing firms		
	EB_eo	EB_p	EB_pu	EB_eo	EB_p	EB_pu	EB_eo	EB_p	EB_pu
MBA	3 (5.17)	2 (25.00)	2 (15.38)		3 (17.65)	4 (100.00)	4 (6.67)	5 (41.67)	4 (57.14)
BE	1 (1.72)			4 (7.84)	7 (41.18)		24 (40.00)	3 (25.00)	3 (42.85)
Post graduate/LLB and CA	14 (24.14)	1 (12.50)	6 (46.15)	19 (37.25)	5 (29.41)		15 (25.00)	4 (33.33)	
Graduate	33 (56.90)	5 (62.50)	5 (38.46)	21 (41.18)	2 (11.76)		10 (16.67)		
Under graduate	7 (12.07)		(13.73)	7			7 (11.67)		
Total	58	8	13	51	17	4	60	12	7

Note: Figures in parentheses are the column percentage.

Table 3.2 Owner's age and pattern of the adoption of e-business

Owner's age	Intensity of e-business								
	Garments manufacturing firms			Auto-components manufacturing firms			Electrical and electronic goods manufacturing firms		
	EB_eo	EB_p	EB_pu	EB_eo	EB_p	EB_pu	EB_eo	EB_p	EB_pu
<35	5 (8.62)		1 (7.69)		1 (5.88)	1 (25.00)	2 (3.33)	1 (8.33)	2 (25.00)
35–39	9 (15.52)	2 (25.00)	3 (23.08)	3 (5.88)	4 (23.53)	2 (50.00)	13 (21.67)	2 (16.67)	
40–44	7 (12.07)	1 (12.50)	2 (15.38)	2 (3.92)	7 (41.18)	1 (25.00)	11 (18.33)	4 (33.33)	3 (37.50)
45–49	11 (18.97)	3 (37.50)	3 (23.08)	13 (25.49)	2 (11.76)		6 (10.00)	2 (16.67)	2 (25.00)
50–54	14 (24.14)	2 (25.00)	4 (30.77)	9 (17.65)			3 (5.00)	2 (16.67)	
55–59	7 (12.07)			17 (33.33)	2 (11.76)		12 (20.00)	1 (8.33)	
60+	5 (8.62)			7 (13.73)	1 (5.88)		13 (21.67)		1 (12.50)
Total	58	8	13	51	17	4	60	12	8

Note: Figures in parentheses are the column percentage.

In the garments sector, the owner's age appears to have little or no impact on the use of e-business technologies, as the sample firms have adopted e-business tools to varying degrees irrespective of the owner's age. However, this is not the case in modern-sector firms. Here the trend in the adoption of e-business in relation to the owner's age is similar in both the auto-components manufacturing and electronic good sectors. In these sectors, 25 per cent of EB_pu firms are managed by persons who are less than 35 years old while only 7.69 per cent of the managers of EB_pu garments firms are in the same age category.

Table 3.3 presents the pattern of the adoption of e-business technologies in relation to the skill intensity of the sample firms. Across all the sampled sectors, there is nominal variation in the skill intensity of firms that adopted the lowest level of tools compared to those that are the most advanced users of e-business technologies. We observed that the slope of the relationship between skill intensity and the use of e-business technologies is downward in the labour-intensive garments sector.

In this sector, the percentage of engineers in the total workforce in EB_eo firms is 0.56, while the percentage in EB-pu firms is 0.26. This could be attributable to the limited use of e-business technologies in developing countries in this sector. Generally e-business technologies are not used in the core production process, that is, garments assembly, which constitutes the major percentage of employment, although modern technologies are used for design, marker making, office automation and co-ordination of business activities with other partners. While firms require qualified staff to manage these new technologies, the required number is low and does not vary with the total employment of firms. This peculiar relationship between the skilled workforce and the total employment figure results in decreasing skill intensity in large firms that use advanced new technologies.

In other words, while computing skill intensity in this sector the numerator remains unchanged but the denominator increases with the use of advanced e-business technology. This brings down the skill intensity of advanced users of e-business tools. As far as the changes in skill intensity of firms in modern sectors are concerned, it is greater in firms using advanced e-business technology. However, the change is negligible. For instance, in the electrical and electronic goods sector, the skill intensity of EB_eo firms is 2.02 while it increases marginally to 2.91 in portals using firms.

In Table 3.4 we present the labour intensity and the use of e-business technologies. The table clearly shows that level of employment is associated with the adoption of new technologies in all three sectors.

Table 3.3 Employee's skill intensity and degree of the adoption of e-business

Employees' qualification	Intensity of e-business								
	Garments manufacturing firms			Auto-components manufacturing firms			Electrical and electronic goods manufacturing firms		
	EB_eo	EB_p	EB_pu	EB_eo	EB_p	EB_pu	EB_eo	EB_p	EB_pu
Engineers	38 (0.56)	12 (0.43)	22 (0.26)	22 (0.46)	30 (0.64)	34 (0.84)	83 (2.02)	25 (2.10)	55 (2.91)
PG/graduates	567 (8.36)	89 (3.20)	404 (4.83)	641 (13.37)	635 (13.50)	530 (13.06)	441 (10.76)	137 (11.48)	215 (11.38)
Diploma holders	102 (1.50)	32 (1.15)	145 (1.73)	3579 (74.62)	3407 (72.46)	2981 (73.48)	3188 (77.78)	923 (77.39)	1476 (78.10)
Others	6071 (89.57)	2645 (95.21)	7792 (93.17)	554 (11.55)	630 (13.4)	512 (12.62)	387 (9.44)	108 (9.05)	144 (7.62)
Total	6778	2778	8363	4796	4702	4057	4099	1193	1890

Note: Figures in parentheses are the column percentage.

Table 3.4 Labour intensity and pattern of the adoption of e-business

Employment size	Intensity of e-business								
	Garments manufacturing firms			Auto-components manufacturing firms			Electrical and electronic goods manufacturing firms		
	EB_eo	EB_p	EB_pu	EB_eo	EB_p	EB_pu	EB_eo	EB_p	EB_pu
< 25	3 (5.17)			3 (5.88)			10 (16.67)		
25–49	10 (17.24)			16 (31.37)			17 (28.33)	1 (8.33)	
50–99	21 (36.21)	1 (12.50)	1 (7.69)	13 (25.49)			22 (36.67)	5 (41.67)	1 (12.50)
100–199	14 (24.14)	2 (25.00)		16 (31.37)	4 (23.53)		10 (16.67)	6 (50.00)	3 (37.50)
200–399	9 (15.52)	2 (25.00)	5 (38.46)	3 (5.88)	9 (52.94)		1 (1.67)		3 (37.50)
400–799	1 (1.72)	3 (37.50)	4 (30.77)		4 (23.53)	3 (75.00)			1 (12.50)
800+			3 (23.08)			1 (25.00)			
Total	58	8	13	51	17	4	60	12	8

Note: Figures in parentheses are the column percentage.

In the garments sector, 53.85 per cent of EB_pu firms employ more than 400 persons while EB_eo firms in this category represent only 1.72 per cent. Similarly, in the auto-components industry 76.47 per cent of firms using advanced e-business technology employ more than 200 persons, while those firms using the lowest level of e-business technology with a total workforce of more than 200 is merely 5.88 per cent. The electrical and electronics goods sector reflects the trend observed in the other two sectors, with 50 per cent of EB_pu firms employing more than 200 workers while only 1.67 per cent of EB_eo firms have similar levels of employment.

Table 3.5 presents the relationship between capital intensity and the adoption of new technologies. We preferred to use per capita capital employed by firms rather than absolute value of capita. It can be seen from Table 3.5 that there is no observable trend between the adoption of new technologies and the capital intensity of firms; this premise holds true in all sectors in the study. In fact the average per capita capital employed by EB_pu firms is less than that employed by EB_eo firms in all the sectors. However, this is not the case if we analyse the data in different categories of firms. For instance, the average per capita capital employed by EB_pu firms in the garments manufacturing sector is Rs 48,940 (approximately USD 1087) in the category of less than Rs 75,000 (approximately USD 1666), while it is Rs 37,030 (approximately USD 823) in EB_eo firms.

One possible reason for the downward slope of the per capita capital intensity and degree of the use of e-business technologies could be the relationship between the size of employment and the adoption of e-business tools. As shown in Table 3.5, generally firms with larger employment adopted more advanced e-business tools. Also, the increase in capital is never proportional to the increase in employment. Consequently, the per capita capital employed by large firms is less than that employed by others, although larger firms may employ a larger absolute amount of capital.

Table 3.6 shows the relationship between the size of the firm's operation and the adoption of e-business technologies.

It can be seen from Table 3.6 that sales turnover, which provides financial strength for any innovative activity, played an important role in the adoption of e-business technologies. Although the e-business tools needed for garments manufacturing are not costly, the majority of firms with larger operations have adopted the more advanced e-business tools. The adoption of such tools may not have been influenced by their cost, but by their capacity utilization and other exigencies. We suspect

Table 3.5 Capital intensity and pattern of the adoption of E-business

Capital per Employee (Rs.in thousands)	Intensity of e-business								
	Garments manufacturing firms			Auto-components manufacturing firms			Electrical and electronic goods manufacturing firms		
	EB_eo	EB_p	EB_pu	EB_eo	EB_p	EB_pu	EB_eo	EB_p	EB_pu
< 75									
No.	32	7	9	2		1	1	1	1
Col. %	55.17	87.50	69.23	3.92		25.00	1.67	8.33	12.50
Avg.	37.03	32.39	48.94	74.10		74.09	69.66	59.57	69.06
75–<100									
No.	10	1	2	10	6		9		2
Col. %	17.24	12.50	15.38	19.61	35.29		15.00		25.00
Avg.	90.25	76.55	86.01	88.54	85.35		88.53		87.05
100–<125									
No.	7			13	3	1	13	1	
Col. %	12.07			25.49	17.65	25.00	21.67	8.33	
Avg.	109.12			113.20	110.99	119.18	110.88	118.61	

125–<150									
No.	3		1	16	4	1	13	5	1
Col. %	5.17		7.69	31.37	23.53	25.00	21.67	41.67	12.50
Avg.	133.75		137.58	137.74	138.09	125.89	134.65	137.88	125.29
150–<175									
No.	1			10	4	1	15	2	3
Col. %	1.72			19.61	23.53	25.00	25.00	16.67	37.50
Avg.	170.06			159.22	157.87	159.53	162.51	165.81	167.97
175 +									
No.	5		1				9	3	1
Col. %	8.62		7.69				15.00	25.00	12.50
Avg.	262.33		190.84				183.24	184.44	191.08
Total									
No.	58	8	13	51	17	4	60	12	8
Avg.	81.64	37.91	72.38	123.56	119.35	119.67	135.75	146.04	132.93

Table 3.6 Firm size and pattern of the adoption of e-business

Sales turnover (Rs. in million)	Intensity of e-business								
	Garments manufacturing firms			Auto-components manufacturing firms			Electrical and electronic goods manufacturing firms		
	EB_eo	EB_p	EB_pu	EB_eo	EB_p	EB_pu	EB_eo	EB_p	EB_pu
< 25									
No.	13			3			5		
Col. %	22.41			5.88			8.33		
Avg.	12.95			22.08			15.61		
25–< 50									
No.	16			17			13	1	
Col. %	27.59			33.33			21.67	8.33	
Avg.	39.79			37.94			37.07	46.36	
50–<100									
No.	14	4		12			24	3	1
Col. %	24.14	50.00		23.53			40.00	25.00	12.50
Avg.	71.80	62.74		72.37			68.17	87.43	85.40
100 - <200									
No.	15	4	5	16	9		15	8	2
Col. %	25.86	50.00	38.46	31.37	52.94		25.00	66.67	25.00
Avg.	131.56	143.69	177.84	124.20	184.20		135.87	136.34	180.52
200 +									
No.			8	3	8	4	3		5
Col. %			61.54	5.88	47.06	100.00	5.00		62.50
Avg.			395.57	278.77	331.98	916.26	232.39		285.47
Total									
No.	58	8	13	51	17	4	60	12	8
Avg.	65.24	103.21	311.83	86.34	253.74	916.26	82.19	116.61	234.23

that the export orientation of firms in the garments sector was a driving force in their adoption of these tools as changes in garments design are more frequent in international markets than domestic markets. However, this argument does not hold true for the firms in the other two sectors, where export intensity is nearly zero. All the firms, irrespective of size, adopted office automation techniques and electronic messaging systems.

Table 3.7 presents the distribution of firms by their age and the adoption of new technologies. The distribution does not follow a uniform pattern across all the sectors as the majority of firms in the garments sector that came into existence before 1985 have adopted e-business tools according to their need.

In contrast to the garments sector, modern sectors have followed the established pattern, as in these sectors age seems to have influenced the adoption of new technologies. This corresponds with our expectations, as most modern–sector SMEs came into existence after the Indian economy's 1985 liberalization process. In the electronics sector, the major hindrance in establishing SMEs in the pre-liberalization era was the availability of raw material (capacitors, PCBs, ICs, LSIs and VLSIs), while the auto-components sector was hampered due to lack of a domestic market in this same period. In 1991, major policy reforms were carried out as part of the liberalization process, and several automobile companies came in existence. This provided momentum for the growth of the auto-components manufacturing sector. The 1991 reforms made the import of raw material and capital goods much simpler and consequently the firms that were established during liberalization period started with latest technologies.

In Table 3.8 we have related the adoption of new technologies to the profitability of the firms. The adoption of e-business technologies seems to have contributed to the lower profitability category. In fact, the profitability of firms that use the more advanced tools is lower than those that use office automation tools in the first profitability category. For instance, firms in the auto components sector that use office automation tools have a profit factor of 4.67 per cent, compared to a profit factor of 4.3 per cent for those that adopted e-business tools in the production process.

At the aggregate level, however, the relationship is positive across all the sectors. The sample firms that have adopted the more advanced tools have experienced higher profitability than those that have not made this transition. Although the contrast between the profitability of EB_p and EB_pu is not very large in the garments sector, it is quite large in modern

Table 3.7 Distribution of firms by age and the adoption of e-business

Year of establishment	Intensity of e-business								
	Garment manufacturing firms			Automobile components manufacturing firms			Electrical and electronic goods manufacturing firms		
	EB_eo	EB_p	EB_pu	EB_eo	EB_p	EB_pu	EB_eo	EB_p	EB_pu
Up to 1980	16 (27.59)	1 (12.50)	10 (76.92)	4 (7.84)	3 (17.65)		2 (3.33)		
1981–1985	21 (36.21)	5 (62.50)	2 (15.38)	17 (33.33)	9 (52.94)	1 (25.00)	10 (16.67)	1 (8.33)	1 (12.50)
1986–1990	16 (27.59)	1 (12.50)	1 (7.69)	11 (21.57)	2 (11.76)	2 (50.00)	19 (31.67)	4 (33.34)	1 (12.50)
1991–1995	5 (8.62)	1 (12.50)		16 (31.37)	3 (17.65)	1 (25.00)	24 (40.00)	6 (50.00)	5 (62.50)
1996 +				3 (5.88)			5 (8.33)	1 (8.33)	1 (12.50)
Total	58	8	13	51	17	4	60	12	8

Note: Figures in parentheses are the column percentage.

Table 3.8 Profitability and pattern of adoption of e-business

Profitability (%)	Intensity of e-business								
	Garments manufacturing firms			Auto-components manufacturing firms			Electrical and electronic goods manufacturing firms		
	EB_eo	EB_p	EB_pu	EB_eo	EB_p	EB_pu	EB_eo	EB_p	EB_pu
<5									
No.	9			3	1		13	2	
Col. %	15.52			5.88	5.88		21.67	16.67	
Avg.	4.00			4.67	4.30		4.02	3.92	
5–< 7.5									
No.	17	3	2	25	4		24	5	1
Col. %	29.31	37.50	15.38	49.02	23.53		40.00	41.67	12.50
Avg.	6.4	5.82	7.20	6.96	6.35		5.95	5.73	6.02
7.5–<10									
No.	19	2	7	22	9	1	18	3	3
Col. %	32.76	25.00	53.84	43.14	52.94	25.00	30.00	25.00	37.50
Avg.	8.69	8.76	8.51	5.53	8.47	8.50	8.75	8.63	9.09
10 +									
No.	13	3	4	1	3	3	5	2	4
Col. %	22.41	37.50	30.77	1.96	17.65	75.00	8.33	16.67	50.00
Avg.	11.61	13.39	13.31	10.20	12.23	13.70	10.72	10.41	12.84
Total									
No.	58	8	13	51	17	4	60	12	8
Avg.	7.95	9.39	9.79	7.57	8.39	12.40	6.77	6.93	10.58

sectors. We attribute this to the contribution of new business tools used in production as well as the Internet-based non-production processes.

3.2 Ugandan firms

As the types of tools adopted by sample firms in Uganda were different from those adopted in India, the intensity of the adoption of e-business has been measured on a different scale. Sample firms were grouped in five categories: no_EB, EB_tf, EB_eo, EB_p and EB_i. The first category, no_EB, are firms that do not use any kind of e-business tools. The second category, EB_tf, are firms that use telephone and fax machines, while firms categorised as EB_eo are those that use office automation tools and electronic messaging systems in addition to telephone and fax. The fourth category, EB_p, are firms that use e-business tools in production processes, and the final category, EB_i, are firms that use the Internet to co-ordinate their activities with other firms. Although we have grouped EB_p firms separately, no meaningful inferences can be drawn from the sample firms because only three firms have adopted e-business tools in the production processes. Unlike in India, the sample firms belong to two industries: automobile parts manufacturing and food and beverage. The pattern of the adoption of e-business, along with the industry-specific characteristics of the sampled Ugandan firms, is presented in Tables 3.9–3.16.

The relationship between the academic qualification of the owners or managing directors and intensity of the e-business adoption is presented in Table 3.9. It can be observed from Table 3.9 that the academic qualifications of the sample firms' managing directors does not have an influence in the adoption of new business methods. This pattern is similar in both sectors.

These results are not surprising as the e-business tools adopted by sample firms, namely, electronic messaging systems, office automation and the Internet, do not require an in-depth technical understanding of their applicability and performance. Evidently, Ugandan firms use e-business technologies in their peripheral activities rather than in their core activities.

Table 3.10 presents the distribution of firms according to the managing directors' ages and the firms' adoption of e-business technologies. Although we have observed that the pattern of adoption of modern tools is not influenced by sector-specific factors, there is a positive association between the adoption of new technologies and the age of managing directors. Persons under 35 years managed 66.7 per cent of the EB_eo

Table 3.9 Owner's qualification and degree of the adoption of e-business

Owner's Qualification	Intensity of e-business									
	Auto-components manufacturing firms					Food and beverages firms				
	no_EB	EB_tf	EB_eo	EB_p	EB_I	no_EB	EB_tf	EB_eo	EB_p	EB_i
Engineers	1 (12.50)	5 (19.23)	1 (33.33)					3 (75.00)		3 (16.67)
Technical diploma	6 (75.00)	8 (30.77)			3 (42.86)	2 (40.00)	5 (50.00)	1 (25.00)	1 (50.00)	4 (22.22)
Others	1 (12.50)	10 (38.46)	2 (66.67)		3 (42.86)	3 (60.00)	4 (40.00)			7 38.89)
No response		3 (11.46)		1 (100.00)	1 (14.28)		1 (10.00)		1 (50.00)	4 (22.22)
Total	8	26	3	1	7	5	10	4	2	18

Note: Figures in parentheses are the column percentage.

Table 3.10 Owner's age and pattern of the adoption of e-business

Owner's age	Intensity of e-business									
	Auto-components manufacturing firms					Food and beverages firms				
	no_EB	EB_tf	EB_eo	EB_p	EB_I	no_EB	EB_tf	EB_eo	EB_p	EB_i
<35		2 (7.70)	2 (66.67)			2 (40.00)	1 (10.00)			1 (5.56)
35–39	3 (37.50)	4 (15.38)		1 (100.00)	2 (28.57)		3 (30.00)	1 (25.00)	1 (50.00)	3 (16.67)
40–44	2 (25.00)	4 (15.38)			1 (14.29)	1 (20.00)	3 (30.00)	3 (75.00)	1 (50.00)	8 (44.43)
45–49	3 (37.50)	8 (30.77)			2 (28.57)		1 (10.00)			1 (5.56)
50 +		8 (30.77)	1 (33.33)		1 (14.29)	2 (40.00)	2 (20.00)			1 (5.56)
No response					1 (14.29)					4 (22.22)
Total	8	26	3	1	7	5	10	4	2	18

Note: Figures in parentheses are the column percentage.

type of firms in the automobile parts manufacturing sector, while persons in the age category of 35–44 years managed all the EB_eo firms in the food and beverage sector. The majority of managers in both sectors (71.43 per cent for automobile parts, 66.67 per cent for food and beverage) were under 50 years old.

Table 3.11 links the skill intensity of firms to the intensity of new business techniques adoption. Although the sectors in the Uganda study are not skill intensive, the adoption of new business tools shows a positive relationship to the skill intensity of firms.

As Table 3.11 reveals, the majority of workers (74.07 per cent) in EB_tf firms of the auto-components sector do not hold diplomas, although this reduces to 50 per cent in EB_eo firms. Surprisingly, the skill intensity of the majority of EB_i firms in this sector is also very low. The scenario is quite similar in the food and beverage sector.

Table 3.12 presents the distribution of firms by their level of employment and degree of e-business tool adoption. As the table demonstrates, the adoption of new tools is associated with the employment level of firms. In the automobile parts sector, 88.46 per cent of EB_tf firms employ less than four workers while 66.67 per cent of EB_eo firms, those that use office automation and e-mail systems, employ more than four persons. We suspect that the reason all the EB_i firms, those that use the Internet, employ less than four workers is that these firms are trading firms. As their main activity is the co-ordination of buyers and suppliers, they do not require more workers to manage the firm's activities; they have achieved efficient co-ordination through the adoption of e-business tools.

The scenario in the food and beverage sector is similar to that of the automobile parts sector, although here the average employment level of the firms that have adopted office automation tools is nine. In this sector a large number of firms (72.22 per cent) that were using the Internet also employed fewer than four people. We also suspect that many of EB_i firms in this sector are trading firms and hence employ fewer workers and compensate through the use of more advanced e-business tools (e-mail and the Internet systems) than the sample firms involved in manufacturing.

The next table examines the relationship between capital intensity per employee and the use of new technologies. Table 3.13 shows that industry-specific factors have influenced the use of new tools. In the automobile parts sector, the capital investment follows a normal distribution in EB_i firms, while in the food and beverage sector, it has an upward trend. Only 22.22 per cent of EB_i firms employ less than 0.5

Table 3.11 Employee's skill intensity and degree of e-business adoption

Employee's Qualification	Intensity of e-business									
	Auto-components manufacturing firms					Food and beverages firms				
	no_EB	EB_tf	EB_eo	EB_p	EB_I	no_EB	EB_tf	EB_eo	EB_p	EB_i
Engineers		2 (3.70)	1 (8.33)				4 (13.79)	1 (2.78)		1 (1.52)
PG/ graduates	1 (6.25)	4 (7.41)				1 (14.29)	2 (6.90)	6 (16.67)	2 (28.57)	5 (7.58)
Diploma holders	3 (18.75)	8 (14.81)	5 (41.67)	1 (50.00)	2 (16.67)	1 (14.29)	4 (13.79)	6 (16.67)	3 (42.86)	19 (28.78)
Others	12 (75.00)	40 74.07)	6 (50.00)	1 (50.00)	10 (83.33)	5 (71.42)	19 (65.52)	23 (63.89)	2 (28.57)	41 (62.12)
Total	16	54	12	2	12	7	29	36	7	66

Note: Figures in parentheses are the column percentage.

Table 3.12 Labour intensity and pattern of adoption of e-business

Employment size	Intensity of e-business									
	Auto-components manufacturing firms					Food and beverages firms				
	no_EB	EB_tf	EB_eo	EB_p	EB_i	no_EB	EB_tf	EB_eo	EB_p	EB_i
< 4	6 (75.00)	23 (88.46)	1 (33.33)	1 (100.00)	7 (100.00)	5 (100.00)	8 (80.00)		1 (50.00)	13 (72.22)
4 +	2 (25.00)	3 (11.54)	2 (66.67)				2 (20.00)	4 (100.00)	1 (50.00)	5 (27.78)
Average size	2.00	2.08	4.00	2.00	1.71	1.40	2.90	9.00	3.50	3.67
Total	8	26	3	1	7	5	10	4	2	18

Note: Figures in parentheses are the column percentage.

Table 3.13 Capital intensity and pattern of the adoption of e-business

Capital per employee (shillings in millions)	Intensity of e-business									
	Auto-components manufacturing firms					Food and beverages firms				
	no_EB	EB_tf	EB_eo	EB_p	EB_i	no_EB	EB_tf	EB_eo	EB_p	EB_i
< 0.5										
No.		3	1		1	1	2			2
Col. %		15.00	33.33		20.00	25.00	25.00			22.22
Avg.		0.16	0.40		0.43	0.40	0.38			0.20
0.5−< 1.0										
No.	2	2				1	2			
Col. %	33.33	10.00				25.00	25.00			
Avg.	0.70	0.63				0.90	1.00			
1.00−< 5.00										
No.	1	7	1		2		2			
Col. %	16.67	35.00	33.33		40.00		25.00			
Avg.	2.20	2.67	1.20		3.70		2.65			
5.00−<175										
No.	2	7	1		1	2	2	2		2
Col. %	33.33	35.00	33.33		20.00	50.00	25.00	100.00		22.22
Avg.	90.00	13.46	12.09		160.00	6.80	10.91	17.60		115.00
175+										
No.	1	1		1	1					5
Col. %	16.67	5.00		100.00	20.00					55.56
Avg.	1375.00	800.00		2150.00	260.00					1645.00
Total										
No.	6	20	3	1	5	4	8	2		9
Avg.	259.77	45.73	4.56	2150.00	85.57	3.73	3.74	17.60		939.49

million Ugandan shillings while 55.56 per cent of EB_i firms employ more than 175 million shillings.

However, we did find a trend when we examined the total per capita capital investment in both sectors. EB_tf firms employed an average per capita capital of 45.73 million shillings in the automobile parts sector while EB_i firms used an average per capita capital of 85.57 million shillings. A similar trend at the aggregate level is followed in the food and beverage sector.

Although we tried to identify the relationship between sales turnover and the adoption of new technologies, only 27.38 per cent of sample firms shared these data with us. However, in both sectors the firms that supplied data correspond with the established trend that adoption of new technologies by firms is influenced by their size of operation.

From Table 3.14 we observe that while 80 per cent of EB_tf firms in the automobile parts sector have sales turnover of less than 3 million shillings, 50 per cent of EB_i firms in the same sector have sales turnover of more than 1000 million Shillings. Although an insufficient number of food and beverage sector firms provided sales turnover data to draw any inferences, it is notable that the percentage of EB_i firms increases with the size of operation.

Table 3.15 shows the distribution of firms by their age and the adoption of new technologies. This does not seem to relate to the adoption of e-business tools although the majority of firms in both sectors that use e-business tools were created after 1991.

As e-mail and the Internet came into general use after 1995, their pattern of adoption is not surprising. However, the trend in telephone use is contrary to our expectations. We suspect that the sample firms installed fax and telephone systems concurrently during their start-up period.

Table 3.16 examines the impact of e-business on the profitability of firms, with profitability computed as the percentage of profit after tax to the sales turnover. Unfortunately, as with the data for sales turnover, only a small minority – 17.85 per cent – of the sample firms provided us with this information.

Given the limited number of firms that provided data for profit after tax, we cannot draw any inferences regarding profitability and the adoption of new technologies. It is noted, however, that 55.56 per cent of the sampled firms in the food and beverage sector that adopted the Internet have achieved more than 20 per cent profitability.

Table 3.14 Firm size and pattern of the adoption of e-business

Sales turnover (shillings in millions)	Intensity of e-business									
	Auto-components manufacturing firms					Food and beverages firms				
	no_EB	EB_tf	EB_eo	EB_p	EB_i	no_EB	EB_tf	EB_eo	EB_p	EB_i
< 3.00										
No.	4				1					
Col. %	80.00				25.00					
Avg.	1.18				1.30					
3.00-< 5.00										
No.							1			1
Col. %							100.00			10.00
Avg.							3.50			3.07
5.00-< 1000										
No.	1				1				1	3
Col. %	20.00				25.00				100.00	30.00
Avg.	9.00				350.00				270.00	147.27
1000-< 3000										
No.					1					4
Col. %					25.00					40.00
Avg.					2800.00					2610.00
3000 +										
No.	1			1	1					2
Col. %	100.00			100.00	25.00					20.00
Avg.	3900.00			6000.00	6600.00					3900.00
Total										
No.	1	5		1	4		1		1	10
Avg	3900.00	2.74		6000.00	2437.8		3.50		270.00	1868.50

Table 3.15 Distribution of firms by age and adoption of e-business

Year of establishment	Intensity of e-business									
	Auto-components manufacturing firms					Food and beverages firms				
	no_EB	EB_tf	EB_eo	EB_p	EB_i	no_EB	EB_tf	EB_eo	EB_p	EB_i
Up to 1985	1 (12.50)	3 (11.54)	1 (33.33)	1 (100.00)	1 (14.29)	1 (20.00)			1 (50.00)	5 (27.78)
1986–1990		2 (7.69)			1 (14.29)			1 (25.00)		1 (11.11)
1991–1995	5 (62.50)	9 (34.62)			2 (28.57)	2 (40.00)	3 (30.00)	2 (50.00)	1 (50.00)	2 (11.11)
After 1995	2 (25.00)	12 (46.15)	2 (66.67)		3 (42.85)	2 (40.00)	7 (70.00)	1 (25.00)		9 (50.00)
Total	8	26	3	1	7	5	10	4	2	18

Note: Figures in parentheses are the column percentage.

Table 3.16 Profitability and pattern of the adoption of e-business

Profitability (%)	Intensity of e-business									
	Auto-components manufacturing firms					Food and beverages firms				
	no_EB	EB_tf	EB_eo	EB_p	EB_i	no_EB	EB_tf	EB_eo	EB_p	EB_i
< 10										
No.										2
Col. %										22.22
Avg.										4.02
10−<20										
No.										2
Col. %										22.22
Avg.										15.51
20 +										
No.	1			1	3				1	5
Col. %	100.00			100.00	100.00				100.00	55.56
Avg.	63.00			95.00	47.31				59.26	71.11
Total										
No.	1			1	3				1	9
Avg.	63.00			95.00	47.31				59.26	43.85

3.3 Nigerian firms

Although we present the pattern of e-business tools adoption in this section, it is restricted to the factors that influenced the use of new technology in Nigerian engineering firms, as the majority of the firms sampled belong exclusively to this sector. The sample selection was deliberate, since our secondary data showed the subsector as likely early adopters of e-business techniques. The sample is classified by the same terms used in the previous section detailing the intensity of e-business in Ugandan firms.

Table 3.17 presents the distribution of firms according to the intensity of the adoption of these technologies in relation to the academic qualification of firms' managing director. We propose that the adoption was influenced by the qualification of managing directors as a significant percentage of managing directors (42.86 per cent) with engineering degrees adopted e-mail and office automation tools.

The engineering industry requires a thorough knowledge and understanding of the suitable tools for production processes. Hence, it is extremely important to evaluate the utility and effectiveness of such tools prior to implementation. This argument is equally valid for the small- and medium-sized firms within the sample group. The firms' managers must first perceive new technology as appropriate. Within the sample firms, advanced academic credentials seem to be a significant factor, as managers of EB_i firms with engineering backgrounds have adopted e-business tools in production processes.

Table 3.17 Managing director's qualification and degree of the adoption of e-business

MD's qualification	**Intensity of e-business**				
	no_EB	**EB_tf**	**EB_eo**	**EB_p**	**EB_i**
Engineers	5 (13.51)	1 (9.09)	9 (42.86)	20 (74.07)	3 (33.33)
Technical diploma	12 (32.43)	4 (36.36)	6 (28.57)	2 (7.41)	4 (44.44)
Others	10 (27.03)			2 (7.41)	
No response	10 (27.03)	6 (54.55)	6 (28.57)	3 (11.11)	2 (22.22)
Total	37	11	21	27	9

Note: Figures in parentheses are the column percentage.

In Table 3.18 we examine the effect of the managing director's age on the adoption of e-business technologies. Contrary to our expectations that younger entrepreneurs would more likely be early adopters of the more advanced new technologies, we found no uniform trend in adoption.

The relationship between the adoption of new technologies to the employee's skill intensity is examined in Table 3.19. The table reveals that the skill intensity of users of advanced e-business tools is higher than others, as EB_tf firms employ only 12.28 per cent engineers while most firms using advanced e-business tools employ 16.98 per cent engineers.

The reverse is true for firms employing more diploma holders. 42.11 per cent of EB_tf employees are diploma holders, whereas this percentage reduces to 25.47 per cent in EB_i firms. The results suggest that there exist a positive relationship between the skill intensity of firms and intensity of the adoption of e-business tools.

Table 3.20 presents the relationship between the employment size of sample firms and the use of new technologies. As expected, there is hardly any link found between the firms using telephone and fax and the size of employment. However, a large percentage (85.72 per cent) of firms that had adopted office automation and email systems employed more than five persons. A similar trend is found in other firms that are also advanced users of new tools.

The results in Table 3.20 are quite interesting. For instance, 77.78 per cent of EB_i firms employed between six and ten workers while 22.22 per cent of such firms employed more than ten workers. This suggests a

Table 3.18 Owner's age and pattern of the adoption of e-business

Owner's age	**Intensity of e-business**				
	no_EB	**EB_tf**	**EB_eo**	**EB_p**	**EB_i**
< 35	8 (21.62)	2 (18.18)	1 (4.76)	4 (14.81)	1 (11.11)
35–39	3 (8.11)	2 (18.18)	5 (23.81)	3 (11.11)	2 (22.22)
40–44	9 (24.32)	1 (9.09)	5 (23.81)	6 (22.22)	1 (11.11)
45–49	8 (21.62)	3 (27.27)	2 (9.52)	6 (22.22)	1 (11.11)
50–54	4 (10.81)	3 (27.27)	5 (23.81)	4 (14.81)	2 (22.22)
55 +	1 (2.70)		1 (4.76)	4 (14.81)	1 (11.11)
No response	4 (10.81)		2 (9.52)		1 (11.11)
Total	37	11	21	27	9

Note: Figures in parentheses are the column percentage.

Table 3.19 Employee's skill intensity and degree of the adoption of e-business

Owner's qualification	**Intensity of e-business**				
	no_EB	**EB_tf**	**EB_eo**	**EB_p**	**EB_i**
Engineers	22 (13.42)	14 (12.28)	40 (12.54)	59 (13.56)	18 (16.98)
PG/graduates	21 (12.80)	37 (32.46)	116 (36.36)	146 (33.56)	35 (33.02)
Diploma holders	50 (30.49)	48 (42.11)	108 (33.86)	145 (33.33)	27 (25.47)
Others	71 (43.29)	15 (13.16)	55 (17.24)	85 (19.54)	26 (24.53)
Total	164	114	319	435	106

Note: Figures in parentheses are the column percentage.

Table 3.20 Labour intensity and pattern of the adoption of e-business

Employ-ment size	**Intensity of e-business**				
	no_EB	**EB_tf**	**EB_eo**	**EB_p**	**EB_i**
≤5	26 (70.27)	5 (45.46)	3 (14.28)		
6–10	8 (21.62)	2 (18.18)	8 (38.11)	12 (44.44)	7 (77.78)
11–20	2 (5.41)	2 (18.18)	3 (14.28)	7 (25.93)	1 (11.11)
21 +	1 (2.70)	2 (18.18)	7 (33.33)	8 (29.63)	1 (11.11)
Total	37	11	21	27	9

Note: Figures in parentheses are the column percentage.

negative relationship between the intensity of the adoption of e-business and employment size. However, this might be invalid if the firms that employed more than ten persons are subsidiaries of larger companies, and so they do not have much co-ordination activities. Consequently, they have not adopted tools that are required for co-ordination activities.

Table 3.21 examines the adoption of new technologies in relation to the per capita investment by firms. When looking at the average investment, it is clear that the more advanced users of e-business technologies have a high per capita investment. For instance, the average per capita investment of firms using fax and telephone was 10,550 naira whereas most firms using advanced e-business tools invested 74,670 naira per employee.

Table 3.21 Capital intensity and pattern of the adoption of e-business

Capital per employee (naira in thousands)	**Intensity of e-business**				
	no_EB	**EB_tf**	**EB_eo**	**EB_p**	**EB_i**
< 1.0					
No.	2			2	
Col. %	10.53			9.09	
Avg.	0.71			0.57	
1.0−< 2.5					
No.	2	5	5	1	2
Col. %	10.53	45.45	26.32	4.55	40.00
Avg.	2.25	1.87	1.47	1.67	1.22
2.5−< 5.0					
No.	4	2	6	6	
Col. %	21.05	18.18	31.58	27.27	
Avg.	5.00	4.09	3.73	4.01	
5.0–< 10.0					
No.	5	3	5	2	1
Col. %	26.32	27.27	26.32	9.09	20.00
Avg.	8.27	8.33	6.61	5.81	5.83
10.0–< 100.0					
No.	5	1	2	9	
Col. %	26.32	9.09	10.53	40.91	
Avg.	19.20	73.53	37.78	44.02	
100.0 +					
No.	1		1	2	2
Col. %	5.26		5.26	9.09	40.00
Avg.	300.00		250.00	280.84	182.54
Total					
No.	19	11	19	22	5
Avg.	24.38	10.55	20.44	45.29	74.67

Table 3.22 examines the relationship between sales turnover and degree of adoption of e-business technologies. Like Indian and Ugandan firms, the relationship between these variables is also positive in Nigerian firms. At the aggregate level, the average size of operation of EB_tf firms was 3.04 million naira while the average sales turnover of most advanced users of new business technologies was 5.93 million naira.

Table 3.22 Firm size and pattern of the adoption of e-business

Sales turnover (naira in million)	**Intensity of e-business**				
	no_EB	**EB_tf**	**EB_eo**	**EB_p**	**EB_i**
< 1.0					
No.		1	7	5	1
Col. %		16.67	41.18	27.78	33.33
Avg.		0.82	0.61	0.56	0.85
1.0–< 2.5					
No.	2	1	2	4	1
Col. %	100.00	16.67	11.76	22.22	33.33
Avg.	1.52	1.04	1.43	1.35	1.50
2.5–< 5.0					
No.		3	6	7	
Col. %		50.00	35.29	38.89	
Avg.		3.63	3.10	3.97	
5.00 +					
No.		1	2	2	1
Col. %		16.67	11.76	11.11	33.33
Avg.		5.50	15.50	12.70	15.45
Total					
No.	2	6	17	18	3
Avg.	1.52	3.04	3.34	3.41	5.93

Although at the aggregate level we noted an increasing trend in the adoption of new technologies in relation to size of operation, there is no uniform pattern when analysed by different levels of sales turnover. For instance, 33.34 per cent of EB_tf firms have sales turnover of less than 2.5 million naira, whereas in EB_eo firms this percentage increases to 52.94 per cent. Surprisingly, this percentage decreases to 50 per cent in EB_p firms and again increases to 66.67 per cent for Internet-using firms. This trend holds true in the other size categories of firms.

In Table 3.23 we have tried to examine the impact of the age of firms on the adoption of e-business tools. Unlike the Indian sample firms, the data presented in Table 3.23 does not show any relationship between these variables. This suggests that there have not been major changes in industrial policies in the recent past in Nigeria to encourage the development of new firms equipped with modern technologies in production, marketing and co-ordination activities.

Table 3.23 Distribution of firms by age and the adoption of e-business

Year of establihment	Intensity of e-business				
	no_EB	**EB_tf**	**EB_eo**	**EB_p**	**EB_i**
Up to 1980	8 (21.62)	4 (36.36)	5 (23.81)	9 (33.33)	1 (11.11)
1981–1985	8 (21.62)	3 (27.27)	3 (14.29)	5 (18.52)	2 (22.22)
1986–1990	6 (16.22)	1 (9.09)	5 (23.81)	11 (40.74)	5 (55.56)
1991–1995	6 (16.22)	3 (27.27)	6 (28.57)	1 (3.70)	
After 1995	7 (18.92)		2 (9.52)	1 (3.70)	1 (11.11)
No response	2 (5.41)				
Total	37	11	21	27	9

Note: Figures in parentheses are the column percentage.

3.4 Comparative analysis

This section deals with the industry- and country-specific factors that have influenced the adoption of e-business technologies in all three countries. The results presented in Sections 3.1, 3.2, and 3.3 suggest that irrespective of the country, the academic qualifications of managing directors in the engineering sector within the sample plays an important role in the adoption of new technologies. The academic qualifications of managing directors plays a crucial role in influencing the adoption of new business technologies in the electrical and electronic goods manufacturing sector in India as well as the engineering industry in Nigeria. Noticeable country-specific factors emerged as significant in the auto-components manufacturing sector in India and Uganda. While in Indian firms the qualifications of owners influenced the degree of adoption of new tools, the results did not show any significant impact in Ugandan firms. The owner's academic qualifications did not influence the adoption of new technologies in food and beverages firms in Uganda.

We had expected that the younger generation would be more technologically inclined and so would conduct their business within the new ICT-dominated technology environment. However, the results presented in above sections do not support this argument. Industry-specific factors have not emerged as significant determinants of the use of new technologies. Although the skill- and knowledge-intensive sector in India demonstrates an important role being played by the age of managing directors, the engineering sector in Nigeria, which is also skill and knowledge-intensive, did reflect the perspective that younger managing

directors were more technology oriented. A similar pattern is found in the auto-components sectors in India and Uganda. The results also suggest that even in low-technology sectors, such as garments manufacturing in India and the food and beverage industry in Uganda, the age of owners is irrelevant with respect to the adoption of e-business technologies.

The sample firms were also classified according to the skill requirements of the workforce. The electrical and electronic goods firms in India and the engineering firms in Nigeria could be grouped as highly skill-intensive firms, while garments manufacturing firms in India and food and beverages firms in Uganda could be grouped as labour-intensive. In our investigation of the impact of skill intensity of workforce on the adoption of e-business tools, we found that skill intensity is a notable factor that has influenced the degree of the adoption of new technologies irrespective of both the sector's skill- or labour-intensive classification as well as their region of operation. In all the countries and sample firms, the skill intensity of the workforce is positively associated with the adoption of e-business technologies. However, when comparing cross-country and cross-industry patterns of the adoption of e-business technologies, we found variations. Electrical and electronic goods manufacturing firms in India have adopted portal and web-based e-business technologies, while the firms in Nigeria have not developed beyond the Internet. Similarly, a large number of firms (26.61 per cent) of the auto-components manufacturing sector in the Indian sample have adopted computerized methods in production processes, while merely 2.22 per cent of Ugandan firms in the same sector have adopted such tools.

There is a significant difference in the intensity of the adoption of e-business between science-based sectors and other sectors. For instance, 16.67 per cent of electrical and electronic goods manufacturing firms in India employing fewer than 25 persons have adopted office automation tools, while roughly 5 per cent of similarly sized firms in other sectors have adopted such e-business tools. This comparison is not possible in Uganda and Nigeria because the sample firms within the sector fall in the labour intensive category, while sample firms in India belong to the science-based sector. A cross-country comparison of firms in science-based sectors does not find similarity in the adoption of new technology. 10 per cent of science-based sample firms in India were doing business using web-enabled technologies, while not a single sample firm in Nigeria had a web site. However, only about 25 per cent of firms in India had adopted new tools in production processes, whereas a

large percentage (34.29 per cent) of firms in Nigeria had adopted new production technologies.

Owing to differences in the currencies used to measure per capita capital investment, it is not possible to analyse the adoption of e-business in relation to investment. We did note that a similar pattern is being followed separately by each industry in each country. For instance, the average per capita investment in Indian garments firms that adopted new technology in the production processes was Rs 37,910. The per capita investment by the most advanced users of e-business technology in the same sector was Rs 72,380. Surprisingly, the average investment by EB_eo firms was Rs 81,640, which is more than that of EB_p firms. Auto-components firms follow a similar pattern; however, the adoption of e-business technologies and per capita investment in the electrical and electronic goods sector shows the reverse trend. In these sectors, the average investment by EB_pu firms was Rs 132,930, while it was Rs 135,750 in EB_eo firms. The auto-components sector in Uganda followed this pattern, while the food and beverage firms showed an increasing per capita investment with respect to the intensity of e-business tools. There is no similarity in the trend of investment by firms in India and Nigeria. In India it was a negative trend shown in the electrical and electronic goods sector, while Nigerian modern-sector firms show a positive trend of per capita investment and degree of adoption of new technology.

The pattern of the adoption of e-business across countries and industries with respect to size of operation is largely uniform, with firms with larger operations adopting the more advanced tools. However, the magnitude of size of operation in relation to degree of adoption varies across industries. For instance, the average sales turnover in garments firms in India that had adopted new technology in production processes was Rs 103.21 million, whereas it was Rs 253.74 million in auto-components firms. Although the trend between the adoption of new technologies and size of operation in Ugandan firms is positive, it is improper to draw any conclusion as so few firms provided data on their size of operation. Additionally a cross-country analysis is not possible due to the difference in units of measurement (currency) of size for operation. However, it is worth noting that the Nigerian firms sampled also showed a positive association between size of operation and degree of adoption of e-business.

A firm's age also seems to have influenced the adoption of e-business in different industries, although the reasons for this may be different from country to country. For instance, 76.92 per cent of EB_pu firms in the Indian garments sector came in to existence before 1980, while

62.5 per cent of firms using web-enabled technology in the electrical and electronic goods manufacturing sector were established between 1991 and 1995. However, this may be because the tools used in this industry are not very costly and do not require customization. Moreover, older firms are more likely to have a large size of operation and hence can afford new technologies once they became available in the world market. On the other hand, the e-business tools used in science-based sectors require customization and are quite costly. The liberalization of the Indian economy in 1991 may have encouraged young entrepreneurs in this sector to develop firms that would be able to adopt the latest technologies available in the world market. Latecomers in Uganda also seem to have adopted the more advanced technologies, as more than 70 per cent of Internet-using firms in the auto-components sector and 61.11 per cent of the firms in the food and beverages industry were established after 1991. However, the firms in Nigeria do not reflect this trend as most of the Internet-using firms were established between 1986 and 1990.

The results show that industry-specific factors did not influence the adoption of e-business technologies even though the intensity of new technology adoption shows an increasing profitability. For instance, the average profitability in EB_eo firms in Indian garments firms was 7.95 per cent, whereas it was 9.79 per cent in firms using the most advanced technology. This pattern is uniform across all three sampled industries in India. However, cross-country analysis is not possible because of the limited response from the firms in Uganda and the lack of any data on profitability from the Nigerian firms.

3.5 Summary and conclusion

Despite the inability to complete a thorough cross-country analysis, the results presented in the previous section suggest that there are country-specific factors that have influenced the degree of the adoption of e-business technologies. The intensity of the adoption of e-business technologies in the skill- and knowledge sectors, such as the electrical and electronic goods sector, was found to be higher than in labour-intensive sectors such as garments manufacturing, auto-components manufacturing, and the food and beverages industry. The knowledge and academic qualifications of the managing director or owner is another factor derived from the skill intensity of the sectors that appears to have played an important role in influencing the intensity of adoption of new technologies.

In addition, the results show that the intensity of e-business tool adoption was not affected by factors such as profitability, size of operation, age of firm or per capita investment at the industry level. However, there are significant variations in the conduct and performance of firms that were using lowest level of e-business tools compared to those that were the most advanced users of new technologies within an industry.

4
Determinants of E-Business Adoption

4.1 Introduction

Most of the studies analysing the causes and consequences of e-business adoption tend to select firms controlled by their size of operation and product mix. Given the paucity of such studies in developing countries, we analyse factors that have the potential to influence the adoption of internal e-business technologies. Internal and external e-business technologies are discussed in Section 4.3. The main objectives of the chapter are:

- identification of clusters of firms based on choice of technology;
- to classify firms in each cluster based on pre-selected criteria;
- to investigate factors that mediated in the adoption of a particular technology;
- to analyse these factors within a multivariate analysis framework in order to identify the key determinants of adoption.

The remainder of the chapter is organized as follows. Section 4.2 presents data sources and information about sample surveys. Section 4.3 discusses the study's methodology and theoretical framework, while Section 4.4 presents the formulated hypotheses. Section 4.5 presents and analyses the statistical results and Section 4.6 summarizes the chapter's findings.

4.2 Data and sample survey

Data were collected from three developing countries, namely Uganda, Nigeria and India. However, for reasons advanced earlier, we analyse the

data for each country separately. In addition, as the intensity of adoption of e-business tools differs considerably in each country, we could not use a common unit of analysis. Instead, once the analysis for each country is completed, we carry out a comparative perspective. Firms sampled from India were from three sectors, namely garments manufacturing, electrical and electronic goods manufacturing, and auto-components manufacturing; the Ugandan firms sampled were drawn from the auto-components and food and beverage sectors; while the engineering and electronic goods manufacturing sector dominated Nigerian sample firms.

Most of the garments manufacturing firms in India are export-oriented, while the firms in the other two sectors were oriented to the domestic market. The average number employed in the garments sector firms was 227 persons while the numbers in the auto-components manufacturing and electrical and electronic goods sectors were 188 and 90 employees respectively. The average size of operation of export-oriented sector firms was Rs 1096.598 million, whereas it was Rs 1719.700 million and Rs 1025.543 million in the auto-components and modern sectors respectively. The average employment size of Indian firms was 167 workers with a size of operation of Rs 1266.204 million.

The firms sampled in Uganda and Nigeria did not report their market preference. The average size of employment in Uganda was much less than that of firms sampled in India and Nigeria, two persons in the auto-components sector and four persons employed in food and beverage sector making three persons the average size of employment reported by Ugandan firms. Only a limited number of Nigerian firms reported their size of operation. In the auto-components sector, based on data from 11 firms, the average size of operation was 1800 million shillings, while in the food and beverage sector it was 1600 million shillings, based on data from 12 firms. The average size of operation of Nigerian firms was 1.98 million naira, while average size of employment was nine persons.

The sample size of the Indian firms was 79, 72 and 80 in garments, auto-components and electronic goods manufacturing sectors respectively. In Uganda, we obtained data from 45 auto-components manufacturing firms and 39 food and beverage sector firms. We collected data from 105 Nigerian firms as well.

4.3 Methodology and framework

E-business technologies are not stand-alone technologies, but rather they have two components. In the first component, units such as

personal computers (PCs), servers and networking equipment are acquired, managed and controlled by the firms. These are the internal technologies. The second component, without which internal e-business cannot function, consists mainly of the communication network available to the society and firms alike. As the management of the communication network is beyond the control of individual firms, they are defined as external technologies. The internal e-business tools that are considered in this study are telephone, MIS, e-mail, Internet, CAD/CAM, CAE and FMS. This study places firms into clusters that correspond with their relevant internal e-business technologies as defined above.

The survey of the sample firms at the country level revealed that the type of technology used varies significantly even after accounting for the differences in the sectors. The e-business technologies used by electrical and electrical goods manufacturing sector in India are significantly different from the ones employed by the same sector in Nigeria. In Nigeria and Uganda, several firms used only the most rudimentary tools while other firms exploited quite advanced ones. In view of this heterogeneity of technologies used by the sample firms, it was not possible to cluster all the sample firms into two or three groups. Therefore, we have clustered firms in each country separately. Consequently, although the sample firms in each country have been grouped into three clusters, the type of e-business technology in a cluster differs significantly from one country to another.

To group the firms into clusters, we used a statistical tool to identify a relatively homogeneous group of firms based on selected characteristics including the internal technologies employed. The algorithm requires information on the number of clusters and based on the known characteristics, computes a composite index. The criteria for convergence are such that the variance of the composite index within a cluster is minimal and the variance between the clusters is maximal. Finally, cluster membership of each case is identified and stored. We have used cluster membership as a dependent variable in identifying the factors that led to the adoption of these internal technologies. Figure 4.1 presents the theoretical framework used in this study.

Within Figure 4.1, the direction of the arrows represents the influence of the variables. As seen in the figure, the knowledge base of the MD is a crucial factor. It is their knowledge base that determines the suitability of the business's workforce. A technically knowledgeable manager is able to evaluate more accurately the kind of skills required for a particular business, and so the knowledge base of MDs affects the skill composition of the workforce. Learning modes, such as formal training

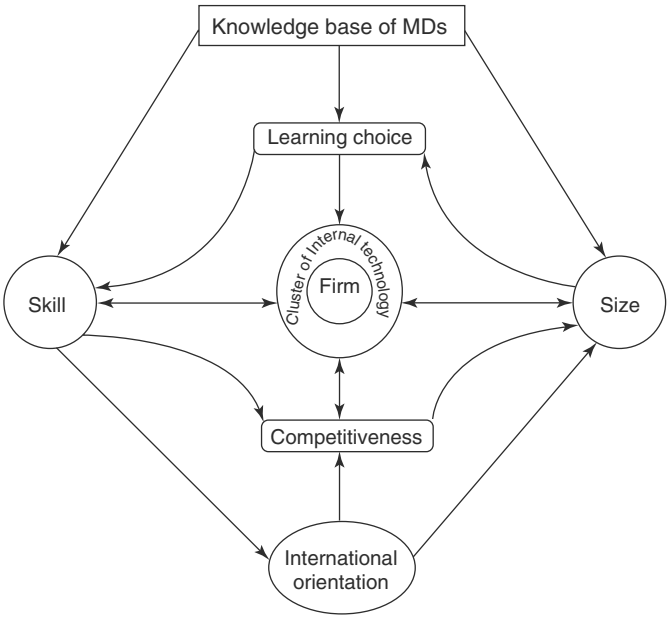

Figure 4.1 Theoretical framework

or learning by doing, are also expected to be significantly influenced by MDs because qualified MDs are in a better position to assess the nature of training to be provided to existing workers. Also, those firms with higher skill intensity and formally trained workers that have previously used new technologies are expected to adopt more advanced e-business technologies.

The adoption of new technologies is a function of the firm's competitive environment. In turn, the competitive environment is affected by the firm's skill intensity and international orientation in areas such as export intensity and technological collaboration with foreign firms. Figure 4.1 shows that competitiveness and international orientation influence the performance of a firm and that the firm's performance and their choice of technology mutually reinforce each other. The figure demonstrates the circular relationship between adoption of new technologies and other factors. However, to identify such relationships would require time series data and as our data is only for 2002, the choices regarding internal e-business technology will be analysed in a single equation framework.

4.4 Hypotheses

The literature on new technology suggests that its diffusion depends on the existing technological capabilities and infrastructure in a country. However, driving forces such as profitability, skills required for successful use of technology, market preferences of firms and competitive environment are common throughout the world. In the following paragraphs we present general hypotheses about these common factors.

4.4.1 Education of managing director

Data on the entrepreneurs' qualification were collected and converted on a three-point quantitative scale. In the sample from India, undergraduates, graduates and postgraduates were ranked as 1, whereas managing directors with Bachelor of engineering (BE) degree were ranked as 2. A number of MDs had additional professional degrees such as Master of Business Administration (MBA); this group has been given the highest rank of 3. This type of quantification of MDs' education was not possible in the other two countries because the nomenclature of degree/diploma earned by MDs were completely different. In these countries, MDs with primary and secondary education were ranked as '1' while technical diploma holders were ranked as '2'. A postgraduate degree in science and a bachelor's degree in engineering are considered similar in Nigeria, so MDs with these qualifications were classified together and ranked as '3'. The few MDs who were science graduates have also been included in the last category. In effect, there are wide variations in formal educational qualifications across countries even though all the three were former British colonies with similar educational systems. The level of industrial development is a factor that determines the skill of workforce including that of the firms' chief executives.

Entrepreneurship has a pivotal place in Schumpeterian and neo-Schumpeterian literature of technological change. Empirically, the role of entrepreneurs' qualifications have been analysed by many scholars. The findings of several studies (Earl, 1989; Cohen, 1995; Lal, 1996) suggest that entrepreneurs' knowledge and qualifications play a very important role in influencing the degree of adoption of ICTs. Drawing upon the theoretical literature and findings of these several empirical studies, we expect that the academic qualifications of the MDs would play an important role in adopting internal e-business technology.

4.4.2 Skill intensity

Like MD's qualification, the level of education of workers varies significantly among the three countries, and hence it was not possible to use

a common definition for skill intensity. In India, skill intensity has been proxied by the number of BE workers employed in the sample firms, while in Uganda we used the number of postgraduate degree holders employed by the sample firms. As the Nigerian sample firms were drawn from the modern sector, we employed the same proxy of skill as in India.

One of the implications of the adoption of new technologies, and particularly ICTs, is the change in the skills composition of the workforce. Several studies (De Laine et al., 2000; Kolling and Schank, 2002; Sabourin, 2001) have examined the role of skilled workers as a determinant of advanced technologies adoption. The study by De Laine et al. (2000) found that the proportion of skilled workers in total employment has increased in Australia since 1978. The authors conclude that there is a strong positive association between technological change and the number of skilled workers employed. In their study of Germany and other OECD countries, Kolling and Schank (2002) concluded that the technological change experienced in plants from 1994–97 has been skill-biased. Sabourin (2001) found in the study of Canadian manufacturing firms that communications technologies and control systems have led to the most recent technological changes. Sabourin's findings suggest that just as new skills are required to work with new machines, new skills are required to manage ICT-led production processes. In view of the theoretical and empirical evidence, we hypothesise a positive relationship between the adoption of new technology and skill intensity.

4.4.3 Value added

Value added is measured as million rupees in Indian firms as the sample firms in other countries did not report any data on value addition. Hence, it was not included in the analysis. Theoretically, the association between value addition and the adoption of new technologies should be positive as new ICT-based production technologies allow modularity and flexibility in product designs that in turn can result in higher value addition. Higher value addition is possible in garments manufacturing owning to the reduced waste of fabric and other raw material because computerized marker-making techniques are able to use fabric more efficiently. A study by Hoffman and Rush (1988) suggests that adoption of microprocessor-based technologies can save up to 6–10 per cent of the manufacturing costs. Since the sample firms consist of garments manufacturing firms, it is expected that those firms that have adopted the more advanced internal e-business technologies experienced higher value addition.

4.4.4 Size of firm

Although Indian firms reported the size of firms in million rupees, most of the firms in the other two countries did not report sales turnover. Hence, we used two separate measures of size for the different countries. For Indian firms, sales turnover was used as a proxy of size, while the total number of workers was used to represent the size for firms in Uganda and Nigeria.

Size of operation is considered a major driving force behind technological change or innovation; it also has implications on the financial support for acquiring new technologies and the firm's ability to successfully adopting them. The size of operation also has implications for the capacity utilization of these technologies. This is a crucial factor for SMEs as they cannot afford capacity under-utilization of new technologies. Several studies (Siddharthan, 1992; Lall, 1983; Lal, 2002) have found a positive relationship between firms' size of operation and the level of their innovative activities. Lal's study in 2002 suggests that size played an important role in the adoption of new technologies by Indian SMEs. The decisions by the firms' MDs regarding acquisition of certain internal e-business technologies are hypothesized to be influenced by size of operation.

4.4.5 Export intensity

As only Indian firms responded with exports data, the variable has been excluded from the analysis of Uganda and Nigeria. Conflicting findings with respect to exports and adoption of advanced technologies have been reported in the literature (Lal, 2002; De Laine et al., 2000). Lal (2002) did not find evidence to support the argument that export intensity influences the adoption of new technology, whereas De Laine et al.'s (2000) study concluded that the intensity of new technology adoption is positively associated with the export intensity in Australian firms. Several reasons have been cited for the conflicting results. The literature argues that firms do not always adopt advanced technologies just to meet challenges in the international markets. If the domestic market is not protected, it becomes imperative for firms to upgrade technology for their survival in this market as well. In such situations, the firm's technological advancements may not be related to their export intensity. Although the Indian market is no longer a protected market, the entry of foreign firms in the SMEs sector is still not very high. Firms operating in the domestic market are not likely to face as severe competition as those firms operating in international markets. Moreover, very advanced e-business technologies may be more beneficial to export-oriented firms.

Hence, it is hypothesized that e-business technologies are positively related to the export performance of firms.

4.4.6 Profitability

The profitability of firms has been computed as a percentage of profit after tax to the sales turnover. However, as data on profitability was not reported in Uganda and Nigeria, this variable has been excluded from the analysis of these countries. An empirical study by Phan (2003) found that Intel improved its profitability after implementing e-business solutions and it is expected that the use of e-business technologies will reduce costs and increase profitability in activities other than manufacturing. This is more likely to be true for SMEs; firms invest in any new technology only when they anticipate immediate returns on investments. Unlike large corporations, SMEs tend to adopt technologies that have short gestation periods. As the sample firms in this study are SMEs, it is expected that their drive for higher profit margins motivate their adoption of e-business technologies.

4.4.7 Learning opportunity variables

Several developing countries have made efforts to modernize their manufacturing capacities by creating export processing zones (EPZ) and special economic zones. Successful establishment of an industrial zone requires certain preconditions such as easy access to the financial market, availability of raw material, custom clearance for the EPZ and good access to labour markets. Incorporating industrial training institutions within economic zones can assist access to the labour market. For the last two decades, the government of India has created several economic zones with modern training institutions in different parts of the country. This study aims to explore the effectiveness of formal training as well as on-the-job training, and includes these two modes of training in the analysis. The opinions of MDs on these variables have been measured on a binary scale with the rank of '1' assigned to important and '0' otherwise.

4.4.7.1 Formal training

Training institutions inside and outside the special economic zones are expected to provide formal training. In India, institutions located within the industrial zones generally provide a two-year training period while institutions outside the zones usually provide training as a four-year degree programme. The major difference between the two types of training is in the nature of the training. Training institutes within the

industrial zones focus on the practical aspects of manufacturing, while institutes external to the zone focus on theoretical aspects. We are unaware of studies that investigated the impact of formal training of workers on the adoption of new technologies, and there have been even fewer studies that focussed on formal training and performance of firms. A recent study by Oyelaran-Oyeyinka (2004) explored the impact of formal training on performance of firms. The results of the study suggest that firms employing formally trained workers performed better than firms employing largely informally trained workers. Formal training is becoming increasingly important in the efficient adoption and operation of relevant e-business technology because of the technology's rapid development. Hence, a positive relationship between the type of internal e-business technology adopted by firms and formal training is expected.

4.4.7.2 Learning by doing

One of the most prevalent forms of skill acquisition in firms is learning by doing. However, this form of training may not be effective or useful where there is a paradigm shift in technological development such as that brought about by advances in ICTs. Therefore, learning by doing should theoretically not have a significant impact on the adoption of e-business technologies. However, several activities in new manufacturing configurations progress by imitation and do not require formal training. This study investigates the role of formal training in the adoption of ICT-led technologies. It is expected that this form of skill acquisition might affect the adoption of internal e-business technologies.

4.4.8 Sources of competitiveness

The last decade of the twentieth century was characterized as the era of liberalization and globalization. Although almost every country has made efforts in this direction, conflicting arguments have been advanced for and against globalization. Proponents of globalization argue that the process will lead to factor-price equalization and access to product and services produced anywhere in the world. Opponents suggest that the process will result in the exit of small firms in developing countries, as they are not capable of competing with large multinational corporations equipped with the latest advanced technologies. Irrespective of positive and negative aspects of globalization, the process is on and it induces competitiveness in domestic as well as international markets. In order to access the impact of competitiveness on the adoption of e-business technologies, we analysed a few sources in this

study. The sources of competitiveness were measured on a five-point scale in the form of opinion expressed by MDs of firms with the value '5' indicating a particular source is most important and '1' indicating it is not important.

4.4.8.1 R&D activities

The sample firms did not have resources required to establish their own R&D units; however, several firms possess the capability to make appropriate changes in product design. In garments manufacturing, product design changes seasonally, particularly in international markets, and it may be difficult for firms to survive in export markets if they are not capable of implementing new designs. As a result, most firms engage in some form of innovation in order to remain competitive. There are frequent design alternations in the electrical and electronic goods sector as new design features are added to products and often the changes require the reconfiguration of the manufacturing processes. Hence, firms in this sector need to be innovative to accommodate the changes in product designs. As production technologies based on ICTs allow easier and cheaper reconfiguration of production processes, we hypothesize that MDs of firms that adopt more advanced internal e-business technology assign higher weight to innovative activities.

4.4.8.2 Brand name

Although the general perception is that the brand name is not very important for small-scale enterprises, the sample firms might, however, assign importance to this element. In the auto-components and garments sectors, the firms are largely suppliers of final products for manufacturing companies or department stores. In both these cases, the firms did not have any incentive to give importance to brand names. However, during the survey it was noticed that a few firms were supplying auto-components to several companies under their own brand name. The MDs of these firms were of the opinion that the brand name was important for them. In the electrical and electronic goods sector, several firms were manufacturing final products and we therefore expect brand name to be an important issue for them. Given the characteristics of sample firms, it is expected that MDs who assigned high importance to brand name adopted more advanced e-business technologies.

4.4.8.3 Technological collaboration with foreign firms

Access to latest technologies is very crucial for firms to remain competitive, and one way to gain access to new technologies is through

technological collaboration with foreign firms. The liberalization of markets in the last decade has made this much simpler in almost every country. Technical collaboration is equally important for firms operating in the domestic market as it is for export-oriented firms. Several scholars (Stiglitz, 1989; Evans and Wurster, 1997) have emphasized that ICTs play an important role in the exchange of information, knowledge and product designs between manufacturers and the suppliers of technology. Improved co-ordination of manufacturing activities is a major contribution of ICTs to the business environment. Hence, we hypothesize a positive relationship between the types of internal e-business tools adopted by firms and the degree of technological collaboration.

4.5 Statistical results

Due to differences in the units of measurement of financial data, it was not possible to analyse the data of all three countries together. Consequently, as indicated in Section 4.3, the sample firms were placed in groups based on the internal e-business technology they used and were then analysed in clusters. After identifying each firm's cluster number, the data were analysed using ordered probit regression analysis. Ordered probit was used because the dependent variable, that is, cluster number, is a discrete and ordinal variable. In each country, the firms were divided into three clusters and labelled as firms using basic e-business tools, moderate users and firms using advanced e-business technology. Although the firms in all the countries have been clustered in one of the three groups, the type of internal e-business technology used by the firms in each country differs significantly. For instance, the three clusters for Indian firms are: (1) e-mail and MIS, (2) URL and CAD/CAM and (3) firms using portals; whereas Ugandan firms form the following three clusters: (1) telephone users, (2) MIS and e-mail and (3) firms using the Internet. Three groups of internal e-business technologies used by Nigerian firms were (1) telephone, (2) MIS and e-mail and (3) FMS, CAD/CAM and Internet.

The analysis of Indian firms is presented in Tables 4.1 and 4.2 while Tables 4.3 and 4.4 present the results of Ugandan data. Descriptive statistics and probit analysis results are presented in Tables 4.5 and 4.6 for Nigerian firms.

4.5.1 Indian firms

Table 4.1 presents the univariate analysis of the variables discussed in Section 4.4. The table shows the mean value of the variables, classified

Table 4.1 Descriptive statistics of variables (Indian firms)

Variables	Intensity of e-business adopted			χ^2 statistics	Significance level
	Low level of e-business using firms	Moderate users	Advanced e-business using firms		
Owner's education	1.348	1.957	2.083	43.116	0.000
Skill intensity	0.880	2.087	4.625	105.285	0.000
Value addition	182.621	405.425	926.211	462.000	0.465
Size of operation	850.400	1811.022	3931.917	429.219	0.015
Exports	698.645	1067.786	2140.463	106.000	0.228
Profitability	7.408	8.668	10.538	377.593	0.167
Learning process					
Training	1.375	1.652	1.375	6.213	0.184
Learning by doing	2.071	2.000	2.208	3.544	0.896
Sources of competitiveness					
R&D	1.913	2.174	2.042	5.755	0.675
Brand name	2.022	1.652	2.375	5.938	0.654

Note: Figures in columns 2, 3 and 4 are mean values of variables.

by their cluster characteristics, along with χ^2 statistics and level of significance. As the table reveals, the type of e-business technology adopted by firms is significantly associated with the MD's education, skill intensity of firms and the firm's size of operation.

The results presented in Table 4.1 suggest that the level of e-business technology adopted by firms was not significantly associated with other variables. Subsequently, the data were analysed in multivariate framework. The results presented in Table 4.2 show four specifications of the probit model. We had to estimate four equations because of multicollinearity among the independent variables. As can be seen from theoretical framework, several variables used in the analysis reinforce each other.

The parameter estimates and corresponding *t*-statistics of the variable included in Equation I suggest that the three variables, skill intensity, export intensity and profitability, emerged as significant influences on the intensity of technology adopted by firms. After dropping these variables and size of operation in Equation II, value addition also emerged as significant. The results of Equations III and IV suggest that MD's education and size of operation are also crucial determinants of e-business technology adoption. The results of the analysis of Indian firms suggest

Table 4.2 Determinants of adoption of e-business in Indian firms

Dependent variable: Intensity of e-business adoption				
Independent variables	**Equations**			
	I	**II**	**III**	**IV**
Owner's education	0.2428	0.1086	0.1856	0.7042***
	(1.196)	(0.712)	(1.285)	(5.605)
Skill intensity	0.3224***			
	(2.955)			
Value addition	–0.0009			
	(–0.298)	0.0038***		
		(6.528)		
Size of operation	0.0006			
	(1.040)		0.0008***	
			(6.195)	
Exports	0.0006***			
	(4.282)			
Profitability	0.1350**			
	(2.557)			
Learning process				
Training	0.3652	0.1892	0.1915	0.2062
	(1.342)	(0.868)	(0.906)	(1.046)
Learning by doing	0.0589	0.0052	–0.0006	–0.0244
	(0.533)	(0.061)	(–0.007)	(–0.337)
Sources of				
competitiveness R&D	–0.0219	0.0379	0.0329	0.0511
	(–0.222)	(0.450)	(0.392)	(0.661)
Brand name	0.0298	–0.0282	0.0005	0.0749
	(0.257)	(–0.359)	(0.007)	(0.998)
Log likelihood function	–77.3864	–99.2534	–101.6262	–132.4832
Significance	0.000	0.0000	0.0000	0.0000

Note: Figures in parenthesis are *t* values.
***Significant at 1 per cent.
**Significant at 5 per cent.

that types of learning processes and sources of competitiveness did not influence the use of internal e-business technology. One possible reason that learning processes were insignificant could be the large numbers of private training institutes that focus on practical training, as well as work experience in the form of apprenticeship. It is mandatory for training institutions that provide industrial training to attach trainees to a firm in the last year of training. Keeping in mind this aspect of learning process, MD's of Indian firms might have shared the same opinion about learning processes. In the test, the learning process has

Table 4.3 Descriptive statistics of variables (Ugandan firms)

Variables	Intensity of e-business adopted			χ^2 statistics	Significance level
	Low levelof e-business using firms	Moderate users	Advanced e-business using firms		
Owner's education	1.700	1.600	2.000	2.152	0.708
Skill intensity		0.130	0.429	20.971	0.000
Size	2.257	5.783	4.286	40.407	0.001
Profitability		52.200	93.795	23.112	0.000
Learning process					
Training	0.003	0.947	0.857	46.692	0.000
Sources of competitiveness					
Technological collaboration	1.424	3.522	2.286	39.667	0.000

Note: Figures in columns 2, 3 and 4 are mean values of variables.

not emerged as significant. Two sources of competitiveness, namely, research and development activities and brand name were included in the analysis. The opinion of MDs on sources of competitiveness does not vary significantly across the clusters, possibly because the firms may be suppliers to main companies and hence these sources of competitiveness are not relevant for them.

Emergence of the MD's education as a significant determinant of the adoption of new technologies is in accordance with Schumpeterian and neo-Schumpeterian literature. MDs with appropriate qualifications and skills are in a better position to assess the type of technology for adoption. They are also aware of the potential benefits of new technologies more precisely than others. The MD's qualification is more important in technology-intensive sectors such as electrical and electronic goods and auto-components manufacturing because internal e-business technologies are very complex in these sectors compared to labour-intensive sector. The emergence of the MD's qualifications as an important determinant in adopting intensity of e-business technologies supports the hypothesis of the study.

The results show that skill intensity significantly influences the choice of technology. Recent technological changes in ICTs are regarded as

Table 4.4 Determinants of adoption of e-business in Ugandan firms

Dependent variable: Intensity of e-business adoption				
Independent variables	**Equations**			
	I	**II**	**III**	**IV**
Owner's education	–0.0004			
	(–0.488)			
Skill intensity	1.5709***			
	(4.504)			
Size	0.0558	0.1675***		
	(0.687)	(2.635)		
Profitability	0.0008			
	(0.803)		0.0012**	
			(1.926)	
Learning process				
Training	0.0003			2.6619***
	(0.373)			(7.034)
Sources of competitiveness				
Technological collaboration	0.3219*			
	(1.829)			
Log likelihood function	–41.9985	–55.1381	–55.0612	–31.1559
Significance	0.0000	0.0003	0.0002	0.0000

Note: Figures in parenthesis are *t*-values.
***Significant at 1 per cent.
**Significant at 5 per cent.
*Significant at 10 per cent.

skill-biased (Kolling and Schank, 2002; Doms et al., 1997). The main reason for a skilled workforce in managing an ICT-led production process is the technology's versatility and programmability. In this skill-based regime, a worker needs to understand how to change parameters of an assembly line without recourse to superiors. For instance, different parameters of an assembly line are needed for manufacturing different types of PCBs in the electronic goods manufacturing sector. The emergence of skill as an important determinant of e-business technology adoption in accordance with existing literature and the hypothesis of the study.

The study also finds evidence to support the argument that adoption of e-business technologies results in higher value addition. A major source of higher value addition could be the reduction of input wastage particularly in the garments sector, while in other sectors it might be through more efficient production processes. For instance, ICT-led production technologies allow the use of more advanced integrated

circuits (VLSI) compared to manual assembly lines, and the use of VLSI in electronic sectors is expected to contribute to higher value addition. The study's findings support the study's hypothesis that size of operations has a bearing on the adoption of new technologies.

In agreement with the existing literature, the results presented in Table 4.2 suggest that export intensity and profitability influence the degree of adoption of internal e-business technologies significantly. A potential rationale for export being a determinant of e-business technologies is the presence of garments manufacturing firms as the majority of sample firms in this sector are export-oriented. It is imperative for such firms to adopt new technologies so that they can incorporate design changes without significant reconfiguration of the production process. The use of ICTs in the production process allows this kind of flexibility. As profit margins in international markets are higher than in the domestic market, profitability is associated with exports. These results support the findings of other studies (Lal, 2002; De Laine et al., 2000).

4.5.2 Ugandan firms

Table 4.3 presents the descriptive statistics of the variables classified by the intensity of e-business technologies adopted by Ugandan firms. The table does not show the role that financial variables played in influencing the use of new technologies because there were very few firms that provided data on sales turnover and profitability. As seen from the table, the academic qualification of the MDs did not emerge significant.

In contradiction with the results of the Indian sample firms, opinion variables have been important in the selection of new technologies. Subsequently, data were analysed in a multivariate framework. As in the case of the Indian firms, it was unavoidable to use the four specifications of the probit model, the results of which substantiate the findings of the univariate analysis. The results are presented in Table 4.4.

Table 4.4 shows that managing director's education is immaterial in the type and the degree of adoption of internal e-business technologies. Not only is this contrary to the existing literature of entrepreneurship and innovation, but it also rejects the hypothesis of the study. We attribute this phenomenon to the sectoral characteristics of the sample firms. Although auto-components manufacturing overall is not a low-technology sector, the sample firms involved manufacture products that mainly require low technology, such as fabricated metal doors, windows, gates and exhaust pipe welding. Given this, the e-business technology tools adopted by the firms are very basic with well-known

benefits that do not require sophisticated technical assessment before adoption. Hence, the education level of MDs did not play any role in selecting e-business tools.

The variables that significantly affected the adoption of internal e-business technologies are skill intensity, size, profitability, learning process and technological collaboration with foreign firms. Although the emergence of skill intensity as an important factor confirms hypothesis of the study, it is surprising because firms were using e-business tools in peripheral activities. A possible explanation is that many of the sample firms were suppliers of auto manufacturing companies that need to effectively co-ordinate with their buyers. Consequently, more qualified persons might have been employed in order to use e-business tools effectively and to produce better quality components.

The results presented in Table 4.4 also show that the profitability of firms that adopted the more advanced tools is higher than those that did not. This could be because of the combination of the two industrial sectors, food and beverage, which is considered labour intensive, and auto-component, which is capital intensive. The literature on profitability and new technologies suggests that the profitability of firms that adopt new technologies in core activities is higher than those that adopt them in peripheral activities. Since none of the sample firms were using new technologies in core activities, sector-specific characteristics might have resulted in this behaviour. Another possibility is that the use of e-mail and the Internet resulted in better co-ordination with suppliers and buyers thus lowering transaction costs and subsequently gaining higher profitability.

The findings of the study are unique in terms of learning processes and technological collaboration with foreign firms. Although most of the firms did not provide data on market preferences, it appears that firms engage in technological collaboration with foreign firms to improve performance in the international market. The findings that firms adopted e-business tools that facilitated business co-ordination support the hypothesis of the study. There are a number of firms owned by individuals with considerable business links with groups outside the country. These links constitute avenues for the acquisition and application of relatively advanced technologies. Another link is through foreign nationals and their partners who establish ICT-based businesses in the country based on the perceived lacuna in the local knowledge base. These and other developments, such as training in ICTs use by international NGOs, open up opportunities for firms to learn of and then apply the new technologies to their businesses.

4.5.3 Nigerian firms

Table 4.5 presents the univariate analysis of Nigerian firms, and quite clearly, the results are different from the other two countries. Despite the selection of Nigerian sample firms from a knowledge- and capital-intensive sector, the academic qualification of the MDs did not emerge as significant in influencing their technological choice.

The univariate analysis results also suggest that the internal competitive environment had no effect on the adoption of new technologies. Like India and Uganda, the data for Nigeria was analysed using ordered probit analysis. The results are presented in Table 4.6. Four different specifications of the probit model were tried for the same reasons given earlier. The results of the multivariate analysis are somewhat different from the univariate analysis.

As the table reveals, the MD's qualification emerged as significant, although the level of significance remains at 10 per cent. Other factors that influenced different levels of adoption of internal e-business technologies are skill intensity, domestic competitive pressure and learning processes. Surprisingly, size did not play a role in influencing the degree of adoption of new technologies. The emergence of the MD's academic qualification as a significant factor is in line with existing literature and supports the hypotheses of the study. Since the Nigerian sample was from the engineering and electronic goods manufacturing sector, e-business tools are used in both peripheral and core activities. The MDs

Table 4.5 Descriptive statistics of variables (Nigerian firms)

Variables	**Intensity of e-business adopted**				
	Low level of e-business using firms	**Moderate users**	**Advanced e-business using firms**	**χ^2 statistics**	**Significance level**
Owner's education	2.35	2.80	2.50	4.497	0.343
Skill intensity	0.97	1.83	4.00	36.748	0.000
Size	7.80	12.50	12.50	58.428	0.010
Reason for e-business adoption					
Internal competition	1.53	2.00	1.00	3.302	0.509
Learning process					
Training	0.42	0.91	1.00	8.260	0.016

Note: Figures in columns 2, 3 and 4 are mean values of variables.

Table 4.6 Determinants of adoption of e-business in Nigerian firms

Dependent variable: Intensity of e-business adoption				
Independent variables	**Equations**			
	I	**II**	**III**	**IV**
Owner's education	0.0005		0.0008*	
	(1.003)		(1.900)	
Skill intensity	0.3468**			
	(2.263)			
Size	–0.0004			
	(–0.011)			
Reason for e-business adoption				
Internal competition		0.0008*		
		(1.902)		
Learning process				
Training			1.5659***	
			(2.737)	
Log likelihood function	–29.7843	–33.0439	–32.8629	–21.5664
Significance	0.0145	0.0448	0.0362	0.0020

Note: Figures in parenthesis are *t* values.
***Significant at 1 per cent.
**Significant at 5 per cent.
*Significant at 10 per cent.

are expected to be aware of the intricacies of e-business tools to reap their potential benefits.

The analysis of the Nigerian data suggests that skill intensity significantly influences the adoption of e-business. Arguments advanced to justify the emergence of skill intensity as a significant factor in Indian firms can also be extended to Nigerian firms. The results show that the internal competitive environment also influences the different levels of e-business technology adoption. This could be attributed to the relatively large number of foreign firms operating in Nigeria in this sector. These foreign firms are better equipped technically with considerable tacit financial resource advantages, and are therefore in a better position to compete in developing countries.

In the big metropolises such as Lagos and Ibadan, where many of the sample firms are based, local private ICT firms have taken advantage of the vast domestic market. Firms require internal capability upgrading in the use of new technologies in order to raise product quality and to master the simple process techniques that are increasingly requiring computer-enabled precision. Ordinarily, because one service provider cannot provide the range of services required, firms approach external

organizations for their diverse requirements. In ideal situations, multiple sources of support, such as productivity centres, research and development institutes (RDIs) and universities, as well as consulting organizations, should be available. The limiting factor is the low number of training centres as well as the relatively poor resources and capability of the available training centres and the firms themselves. As observed earlier, depending on the scale of their operation, the firms need to develop a level of internal assets. The idiosyncratic nature of firm-level process tends to put a limit on the relevance of external resource centres in all but the most exceptional cases. In other words, there is no substitute for internal technological capabilities.

4.5.4 Comparative analysis

The statistical results presented in Section 4.5 suggest that sector-specific factors significantly influence the degree of adoption of internal e-business technologies. For instance, the type of e-business technology adopted by a higher technology sector such as electrical and electronic goods manufacturing is vastly influenced by the knowledge base and qualifications of the MDs. However, the emergence of the MD's skill in Indian sample firms draws largely from labour-intensive garments manufacturing sector, which suggests that the role of the MD's knowledge becomes important for a firm that adopts more advanced technologies. Another contrast in the findings of Indian and Ugandan firms is that the MD's knowledge is important in the auto-components sector in India while it is insignificant in the case of Uganda. We suggest that this is because Ugandan firms use e-business technologies for peripheral activities whereas Indian firms adopted them in core functions. Again, the level of technology corresponds with the complexity and sophistication of products as the Indian firms engaged in relatively higher quality export products, while the Ugandan firms produce low-level products for the domestic market.

The skill intensity of firms emerged as significant in all the three countries; this implies that a prerequisite of successful e-business technology adoption is the knowledge and ability of the users of new technology. The comparative analysis also suggests that country-specific factors resulted in varying degree of e-business adoption. For instance, learning processes and sources of competitiveness were irrelevant for Indian firms while they were highly significant in influencing the e-business adoption pattern in Uganda and Nigeria. This could be a reflection of the technological and human development infrastructure present in these countries. Another contrast noted is that the MDs of Ugandan firms

assigned more importance to technological collaboration with foreign firms than the MDs of Nigerian firms.

Only the firms in India provided financial variables such as size of operation, export intensity and value addition, which emerged significant. However profitability was important in India as well as Uganda. This is not to suggest that financial variables were unimportant in the other two countries, but due to the limited data available from Ugandan and Nigerian firms, they were not included in the analysis. Had the information from these countries been available, it could have allowed a more precise assessment of the importance of financial variables in the adoption of internal e-business technologies.

4.6 Summary

The chapter identifies and analyses the key factors that were determinants of the intensity of internal e-business technology adoption. The study distinguishes between external technologies, namely, those that are needed for e-business but beyond control of individual firms; and internal e-business technologies, those that are acquired, implemented and managed by firms. All the sample firms considered are SMES and belong to the electrical and electronic goods manufacturing, garments manufacturing, auto-components manufacturing, and food and beverage sectors.

The data for each country were analysed separately using two tiers of analytical techniques, specifically cluster analysis and ordered probit analysis, and were used to identify the determinants of internal e-business technology adoption. Based on the type of internal e-business technology they adopted, the sample firms were grouped into three clusters, that is, low, moderate and advanced technology users. Each firm was assigned a number representing the firm's cluster identification that was used as independent variable in ordered probit analysis. Additionally, financial and other firm-specific variables were included in the analysis.

We found that the variables that emerged as significantly influencing the intensity of e-business technology differed from one country to another. The determinants of e-business adoption in Indian firms were size of operation, export performance, profitability, value addition, skill intensity and academic qualifications of the managing directors; however skill intensity size, profitability, learning processes and technological collaboration with foreign firms influenced Ugandan firms. Comparatively, the factors that emerged as significant for Nigerian firms are the knowledge base and academic qualifications of the MDs, skill intensity, internal competition and learning opportunities.

The chapter's findings reflect each country's technological infrastructure and human skills and capabilities. One of the major implications of the study is the required emphasis on formal training in addition to on-the-job training. For instance, over the past two decades, a network of good training institutions were established in the various Indian economic zones, which may explain why MDs of Indian firms did not assign much importance to training opportunities. Although this is not the case in Uganda, a vibrant private ICT business services sector has emerged in Nigeria although it is less advanced and organized than the training culture in India. A potential solution to the need for formal training is private–government partnerships. In this situation, the governments provide logistic support to private institutions that establish training centres in industrial clusters; the close proximity of manufacturing firms to training institutions has the advantage of facilitating practical training to trainees.

Another recommendation of the study is that providing technological and marketing support to firms in developing countries would enhance their ability to compete in international markets. This can be achieved by setting up separate export promotion councils for each sector. These councils can help small firms in exhibiting their products, providing information on market trends and tendering legal services in case of disputes. Export promotion councils can also play a major role in augmenting export performance by assisting in the acquisition and implementation of the latest manufacturing technologies. Also, measures need to be taken to encourage competitiveness in domestic markets as strengthening competitiveness in the domestic market is expected to have positive impact on a firm's global competitiveness.

As discussed in the theoretical framework, there are bi-directional relationships among several factors that emerged as significant determinants of e-business technology adoption although the study has not been able to identify all the causal relationships due to lack of time series data. It may be needless to mention that a simultaneous equation model is more appropriate for those situations. However, it should be noted that the study has identified the factors that influenced one component of e-business technologies. For this reason, further research is needed to identify and analyse the determinants of external e-business technologies.

5

Learning New Technologies by SMEs: Mechanisms and Trajectories

5.1 Introduction

In successful firms, firm-level capabilities would comprise core and 'general-purpose technologies' (GPTs) competencies. The corollary is that successful firms would in turn possess both GPTs and firm-specific skills. The range of GPTs include mechanical engineering and arguably the most pervasive to date, ICTs (Rosenberg, 1994). These technologies are required for, and in fact are indispensable to, the operation of the core routines of organizations. For instance, mechanical engineering is as crucial to the automobile industry as biotechnological skill is key to pharmaceuticals and foods industries. The advent of microelectronics has not only deepened the systemic complexity of all industries, but also revolutionized the nature of industrial organization. Major technological advances in ICTs have caused significant changes in manufacturing; ICTs underlie many of the observed patterns of process and product innovation across industries. At the centre of the manufacturing changes, with significant implications for processing speed as well as flexibility of production and high precision, is the progressive inclusion of microelectronics. While many of these advances have originated in advanced industrial economies, developing countries have taken advantage of these new technologies by building up industrial capabilities through sustained and explicit learning.

In what has come to be known as the technology-skill complementarity (Goldin and Katz, 1998), widespread computerization and the adoption of internal electronic tools within firms augments the skill level of the workforce. In the United States, Autor et al. (1998) found substantial shifts towards tertiary education graduates in industries strongly associated with more rapid growth rate in computer usage and

computer capital per worker. From the advent of electricity, another 'wired' technology, there has been an observed and persistent rise in the skill intensity of manufacturing. According to Goldin and Katz (1998, p. 697), 'technological shift from factories to continuous-process and batch methods, and from steam and water power to electricity, may have been at the root of an increase in the relative demand for skilled labour in manufacturing in early the twentieth century'.

Particularly in small and medium firms that could not previously compete on the basis of scale, digital technologies have led to lower costs and higher quality products. The use of CAD and CAM has revolutionized production in the machinery sector as well as in process industries. The continuous penetration of electronic instruments in traditional sectors has led to renewed interest in, and greater competitiveness of, these sectors. Furthermore, CIM has induced greater speed of production as well as production flexibility in both product and process. However, capitalizing on these developments demands complementary knowledge and skills.

The adoption of e-business technologies employing high-speed computers coupled with advanced telecommunications technologies has not only resulted in relatively lower transactions costs, but also promoted increasing intra-firm and inter-firm integration functions. Fast delivery of customized products and services to customers enhances the profit margin for firms that previously relied on only low-wage and low-skills production. The scope advantage of small firms has been significantly augmented by new technologies, be they manufacturers of batch orders or subcontractors to larger firms. These changes have led to significant shifts in the skill composition of labour and heightened the debate on technology-skill and capital-skill complementarity (Bound and Johnson, 1992; Goldin and Katz, 1998). By this term, the authors mean that 'skilled or more-educated labour is more complementary with new technology or physical capital than is unskilled or less educated labour' (Goldin and Katz, 1998, p. 694 footnote).

Given the technology-skill complementarities, the introduction of ICTs has significant skill implication for developing countries' firms learning to produce for domestic and external markets. The successful adoption of e-business tools is likely to enhance individual workers' productivity in those termed as modern sectors, that is, electronics and general machinery sector. In the more traditional sectors such as textiles, clothing and food, there is a propensity for significant rise in product quality and more precise processing. However, to achieve the goal of better quality products, firms are obliged to undertake greater training

and investment in skills and knowledge upgrading. The implications for long-term industrial competitiveness in developing countries are thus evident regardless of the countries' sectoral comparative advantages.

This chapter presents evidence of learning processes and investment in selected developing countries. We advance three main theses. First, there is clear evidence of increasing complexity in the adoption and use of ICTs among developing-country firms. Second, climbing the technological ladder requires skills upgrading through explicit learning in the new technologies, and for this reason rate of ICT adoption in developing nations had been highly differentiated. Third, firm performance is highly associated with learning capabilities, levels of technology, and a host of firm-level knowledge, skills and experience.

The remainder of the chapter is organized as follows. Section 5.2 presents a theoretical framework while Section 5.3 gives the data sources and the next section presents statistical results, whereas Section 5.5 presents a summary.

5.2 Theoretical framework

From the foregoing, the observed pattern of shifts in the relative mix of skills in manufacturing, the increasing emphasis on knowledge and innovation-driven rather than price-based competition, suggest an equally imperative need for new thinking about economic development in developing countries. These changes are not new but qualitatively they are more intense and arguably occurring more rapidly.[12] We employ a framework drawing on the concepts related to learning processes and technological trajectories followed by firms. The recent and burgeoning literature on technological capability building suggests that knowledge sources that contribute to capability building are external as well as internal to firms. A theoretical framework based on these arguments is depicted in Figure 5.1.

As suggested by Lundvall (1988) and Von Hippel (1988), the accumulation of knowledge takes place not only by developing and employing internal capabilities, but also through learning by interaction with a wide variety of sources. Firms, for example, interact with several external organizations such as technology producers and suppliers. They also gain knowledge through interaction with their customers. In fact, dominant designs and ability for greater flexibility in product designs are often achieved through interaction with product users. The different forms of interaction with technology producers, suppliers and customers are considered extremely important for the technological acquisition

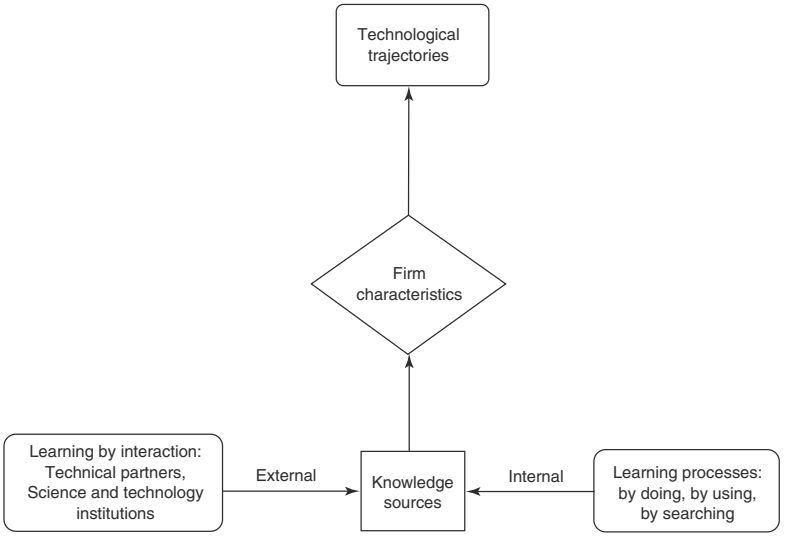

Figure 5.1 Skills effect of learning new technologies

process in firms. The internal processes that lead to technological capability building are training, learning by using and learning by searching, which includes technological improvements, achieved through R&D (Rosenberg, 1982; Dosi et al., 1988). A recent empirical study (Oyelaran-Oyeyinka, 2004) suggests that internal training opportunities greatly contribute to worker productivity, which in turn influences the technological trajectory of firms in Africa. The contribution to knowledge accumulation through internal training is more relevant and prevalent in SMEs because they are less able to organize costly and formal external training. In addition, firms tend to follow certain stable and predictable direction of search processes that draw on their past experiences and build on their competencies over time. For this reason, learning at the firm level takes on a path-dependent character (Nelson and Winter, 1982). Where path dependence generates inertia, old firms may lose out to new ones; where it helps to stimulate innovation, there might be a need for learning and forgetting old skills. Encompassing the external and internal knowledge sources, coupled with other firm-specific factors, our analytical framework explains the technological trajectories followed by the sample firms.

The analytical framework is underpinned by the notion of organizational learning. Several definitions of organizational learning have been

used in the literature. For instance (Morgan, 1986) defines it as follows: '…there is organizational learning when administrative or production unit acquires knowledge that is recognized to be potentially useful to the organization', whereas Huber (1991) argues that learning results from four processes: knowledge acquisition, diffusion of information, interpretation of information and organizational memory (for future use of the knowledge).

Two important elements differentiate measurements of firm-level activities in developing and developed countries. First, the majority of firms' efforts towards improvement are incremental in nature and cannot be captured with the conventional R&D counts of expenditure and the number of scientists and engineers. To this extent, the skills profile of firms in the two contexts differ widely with less importance given to research scientists and much more to technicians and generalists (Huiban and Bouhsina, 1998). This is consistent with the level of technology in use and the more formalized system of research supporting industry in advanced economies, but different from the informal factory wide nature of innovative activities in the developing context. Second, the sources, nature and processes of learning vary with sectors and available national resources. To this extent, the complexity of the use of ICTs will exhibit variation with sectoral and, for our analysis, firm-level capability. Industry is relatively underdeveloped in poor countries and traditional sectors, such as textiles and clothing and foods, constitute the national systems. The sectors termed as hi-tech are only now emerging.

5.3 Data sources and hypotheses

Chapter 2 provides details of the sample sources and survey methods. Again, due to the non-comparability of MD's education and other firm-specific factors such as firm size and type of e-business technologies adopted by firms in the countries, the data from the three countries were analyzed separately.

Since the main objective of the study is to investigate the relationship between the learning processes and the technological trajectory of firms, we formulated the hypotheses on the basis of various types of learning modes prevalent in SMEs. Electronic-business (e-business) technologies adopted by firms have been used as a proxy for technological trajectories. This is because e-business technologies cut across the production processes, and adoption of new technologies has been dominated by ICT-led technologies. The survey found that firms were

mainly using the following technologies: FMS, CNC, CAD/CAM, E-mail, MIS, and web- and portal-enabled technologies.

As mentioned earlier, SMEs dominate the sample firms. Hence, we examined the association of two crucial firm-specific factors on the training modes adopted by sample firms: the academic qualifications of the MDs and the size of the firms. Finally, we investigated the effect of mode of knowledge acquisition on the intensity of e-business technology adopted by firms. The intensity of e-business technology adopted by firms can be used as the proxy for performance in the domestic as well as export markets. Several studies (Lal, 2004; Hodgkinson and McPhee, 2002) found that users of advanced e-business technology performed better than non-users in the export markets. Based on these studies the following hypotheses are formulated.

Hypothesis I: *MD's qualification is associated with type of learning processes*
The decision-making process is very different in SMEs compared to large corporations. In large firms, decision-making is a formal process; decisions are made by a group rather than by individuals, whereas in SMEs, the owners or MDs make almost all the decisions individually. Hence, decisions made in small firms are highly influenced by the knowledge and academic qualifications of the MDs (MDEDU). Due to high turnover of employees in SMEs, decisions relating to the skill upgrading of workers are critical. Correspondingly, skill enhancement[13] activities are very relevant for small firms because they have the tendency to employ less qualified persons and subsequently plan to provide on-the-job training. There are several kinds of on-the-job training, such as learning by doing, sending workers for training provided by technology suppliers, and in-house training; however, the crucial question relates to the type and the adequacy of training provided. A relatively more qualified manager is in a better position to decide on the suitability of a particular training for workers. We hypothesize that MDs having engineering degrees will prefer Internet-based learning processes, and would favour training workers in advanced ICTs.

Hypothesis II: *Firm size is associated with type of learning processes*
Firms with larger size of operation are generally more innovative and have the resources (knowledge and skills) to modify product specifications. Changes to product design can require changes in production technologies and processes that in turn can require training for the users of new technologies. In firms where the product profile remains

static, the need for training is less frequent. Such firms generally operate in markets with little competition and tend to exist in the lower end of SME skills spectrum. We argue in this chapter that firms with larger size of operation are expected to adopt modern learning processes such as Internet-enabled learning. Due to their limited resources, small firms with lower level of operation cannot appropriate the full benefits of new technology-based learning processes. The complexity of ICTs adopted is limited by the size of firm.

Hypothesis III: *Technological Trajectories are significantly influenced by type of learning processes*
The success of new technologies adoption depends on several prerequisites, including the ability of firms to use them effectively and efficiently, the appropriability of benefits of new technologies and the capacity utilization of new methods of production. In SMEs, a major factor in new technologies adoption is the MD's entrepreneurial ability, as other contributing factors, such as skill intensity and appropriability, are derived from entrepreneurship. Another pivotal factor to the adoption of new technologies is the learning process employed by the users of such technologies. Since both modern and so-called traditional technologies are being significantly revolutionized by ICTs, we hypothesize in this study that MDs who appreciate and provide Internet-based learning opportunities are expected to adopt more advanced technologies.

5.4 Statistical results

In order to test the study's hypotheses, we collected data on the various learning processes prevalent in the sample firms. As it is quite possible that multiple learning processes were used to upgrade the skill of workers, the variable (learning process) is a multi-response one. MDs responses are coded on a binary scale. Data on technological trajectories were also collected. Statistical results related to hypothesis I are presented in Table 5.1.

As table 5.1 reveals, in all three countries, irrespective of the academic background of MDs, learning by doing is the dominant means of knowledge acquisition. In Indian firms, 90.91 per cent of MDs with undergraduate degrees employed learning by doing as one of the major options for skill upgrading of workers, while all the MDs with CA and LLB preferred this mode of knowledge accumulation. However, in India, the next most preferred source of learning is through Internet

Table 5.1 Learning processes and MD's education

MDEDU	Learning mode					
	Training	Learning by doing	Internet searching	Learning by interaction	Overseas training	Total firms
India						
BE & MBA	48	63	58	46	39	69
(69.57)	(91.30)	(84.06)	(66.67)	(56.52)		
CA & LLB	9	11	9	6	5	11
	(81.82)	(100.00)	(81.82)	(54.55)	(45.45)	
Graduates	80	121	101	94	89	129
and PGs	(62.02)	(93.80)	(78.29)	(72.87)	(68.99)	
UGs	16	20	18	13	12	22
	(72.73)	(90.91)	(81.82)	(59.09)	(54.55)	
Total firms	231	231	231	231	231	231
Uganda						
Engineer	7	9	3	4	2	13
	(53.85)	(69.23)	(23.08)	(30.77)	(15.38)	
Technical	9	17	5	5	4	30

diploma	(30.00)	(56.67)	(16.67)	(16.67)	(13.33)	
Others	8	22	8	8	8	34
	(23.53)	(64.71)	(23.53)	(23.53)	(23.53)	
No response						7
Total firms	84	84	84	84	84	84
Nigeria						
Engineer	25	27	1	13	1	38
	(65.78)	(71.05)	(2.63)	(34.21)	(2.63)	
Technical	9	8	1	5		28
diploma	(32.14)	(28.57)	(3.57)	(17.86)		
Others	2	1				
	(14.29)	(7.14)				14
No response						25
Total firms	105	105	105	105	105	105

Note: Figures in parentheses are row percentages. Percentages are not expected to add to 100 per cent because of multi-response of MDs.

Table 5.2 Learning processes and firm size

Size	Learning mode					
	Training	Learning by doing	Internet searching	Learning by interaction	Overseas training	Total firms
India						
< 50	38 (63.33)	54 (78.26)	48 (69.56)	32 (46.37)	37 (61.67)	69
50–99	44 (68.75)	60 (93.75)	51 (79.69)	49 (76.56)	32 (50.00)	11
100–200	34 (61.82)	53 (96.36)	41 (74.55)	37 (67.27)	44 (80.00)	129
200 +	37 (71.15)	48 (92.31)	46 (88.46)	41 (78.85)	32 (61.54)	22
Total firms	231	231	231	231	231	231

Uganda						
< 3	21	49	18	18	18	74
	(23.38)	(66.22)	(24.32)	(24.32)	(24.32)	
3 +	8	7	2	3	1	10
	(80.00)	(70.00)	(20.00)	(30.00)	(10.00)	
Total firms	84	84	84	84	84	84
Nigeria						
< 5		2		1		34
		(5.88)		(2.94)		
6–9	16	17	4	10	3	37
	(43.24)	(45.95)	(10.81)	(27.03)	(8.11)	
10–20	12	11		5		15
	(80.00)	(73.33)		(33.33)		
20 +	19	19	1	6	1	19
	(100.00)	(100.00)	(5.26)	(31.58)	(5.26)	
Total firms	105	105	105	105	105	105

Note: Figures in parentheses are row percentages. Percentages are not expected to add to 100 per cent because of multi-response of MDs.

searching, while in Uganda and Nigeria, it is through the in-house training of workers.

The types of e-business technologies used by Indian firms reflect the availability of a reasonably good telecommunications infrastructure; this also explains the Indian preference for the Internet as a source of information for upgrading workers' skills. However, in the other two countries, the level of Internet-based e-business technologies is relatively unsophisticated, which explains why in-house training is the second most preferred mode for upgrading workers' skills. The results presented in Table 5.1 show that the academic qualification of MDs has not influenced the preferred mode of learning. The only exception to this is in Indian sample firms where 84.06 per cent of MDs with BE and MBA degrees preferred Internet-based learning methods, while a smaller proportion of MDs with other academic backgrounds chose the Internet as a source of learning. A possible explanation for this is that MDs with engineering and business management degrees are more aware of the benefits of Internet -based learning processes.

Table 5.2 presents the distribution of the learning mode by the size of the sample firms. We used total number of workers rather than sales turnover as a proxy for size of operation because of the non-availability of sales turnover data for all the sample firms. A large number of degree of freedom would have been lost by considering sales turnover as size of operation.

The results presented in Table 5.2 are similar to the distribution of preferred mode of learning processes by the academic qualifications of MDs. Across all countries, and regardless of the size of operation, the sample firms have indicated learning by doing as the most preferred source of knowledge acquisition. In general, searching through the Internet is the second most preferred mode of skill upgrading by Indian firms, but we have found that larger firms have assigned more importance to Internet searching as compared to firms with a smaller size of operations. The sample firms in the other two countries have given more or less equal importance to the two sources of learning: in-house training and learning by doing. In fact, larger firms in Uganda and Nigeria consider in-house training more important than learning by doing. Of firms employing more than three persons, 80 per cent have chosen in-house training, while 70 per cent of firms in this size category preferred learning by doing method of knowledge accumulation. Similarly, 80 per cent of Nigerian firms employing 10–20 workers chose in-house training as the preferred method, while 73.3 per cent of firms in the same employment category preferred learning by doing.

Presumably, large firms with better financial resources could organize formal training while small producers rely more on learning by doing.

We tested hypothesis III by using the OLS method and bivariate distribution of firms by the technological trajectories that they followed. The bivariate results are presented in Appendix A. As the regression and bivariate analysis results are similar, the discussion is limited to OLS results. It was not possible to pool the data of all the countries because the type of e-business technology employed by sample firms is different across countries. Hence, country-specific parameters were estimated. The type of e-business technology, which is considered a proxy for technological trajectory, has been used as a dependent variable. Parameters of regression equation for each type of technology have been estimated separately. The parameters were estimated using standardized values of variables to negate the effect of discreteness of variables. The results for India, Uganda and Nigeria are presented in Tables 5.3, 5.4 and 5.5 respectively.

Indian firms use five clusters of e-business technologies. Table 5.3 shows that firms using FMS and web sites prefer overseas training to allow for effective and efficient use of the new system. This is because FMSs are in some sense customized systems and specially designed for

Table 5.3 Technological trajectories and learning processes (India)

Dependent variables	**Technologies**				
	FMS	**MIS**	**E-mail**	**Web site**	**Portal**
Training	0.033 (0.501)	0.042 (0.675)	0.114 * (1.742)	−0.056 (−0.853)	0.148 ** (2.297)
Learning by doing	0.045 (0.676)	0.274*** (4.406)	0.160 ** (2.441)	0.091 (1.396)	−0.011 (−0.171)
Internet searching	0.069 (1.036)	0.222*** (3.550)	0.070 (1.060)	0.071 (1.081)	0.045 (0.701)
Learning by interaction	0.079 (1.175)	0.078 (1.237)	0.026 (0.384)	0.076 (1.151)	0.168 ** (2.566)
Overseas training	0.111* (1.664)	−0.004 (−0.057)	0.009 (0.131)	0.170 ** (2.591)	0.141 ** (2.191)
R^2	0.029	0.136	0.047	0.052	0.083
F	1.337	7.095	2.241	2.464	4.060
Significance	0.249	0.000	0.051	0.034	0.002

Note : *, 10%; **, 5%; ***, 1% level of significance.

firm-specific needs. For this reason, general training is hardly appropriate, and not surprisingly, firms that adopted such systems by necessity require specialized training, which is often available only overseas. Table 5.3 also shows that firms using MIS found learning by doing and Internet searching significantly useful. Firms using only e-mail might not have consistent access to the Internet due to low speed and unreliable communication. Some of these firms invariably resort to using e-mail through public switched telephone network (PSTN), a source that is largely unreliable and often technically insufficient for browsing the Internet. Hence, firms using e-mail did not consider Internet searching an adequate tool for skill enhancement. MDs of firms using portal attach importance to training (in-house as well as overseas) and learning by interaction in knowledge upgrading. This confirms our hypothesis that portals provide substantial opportunities for users to interact and learn from each other. In fact, portals are also the most effective way for firms to interact with other business partners.

Table 5.4 presents the regression analysis results for Uganda and shows clear differences in the types of e-business technologies used by Ugandan and Indian firms. Not a single Ugandan firm in the sample had its own web site, nor was any firm using portal-based e-business technologies.

Table 5.4 Technological trajectories and learning processes (Uganda)

Dependent variables	**Technologies**				
	CNC	**FMS**	**MIS**	**E-mail**	**Internet**
Training	0.179***	0.154 **	0.673***	−0.007	0.057
	(3.002)	(2.605)	(7.623)	(−0.067)	(0.514)
Learning by doing	0.032	−0.114***	−0.004	0.057	−0.177 **
	(0.796)	(−3.007)	(−0.066)	(0.969)	(−2.317)
Internet searching			0.714 **	−0.092	−0.092
			(2.381)	(−0.313)	(−0.244)
Learning by interaction	0.023	−0.039	0.260	0.001	−0.086
	(0.175)	(−0.321)	(1.200)	(0.004)	(−0.315)
Overseas training	0.811***	0.833***	−0.690***	1.030***	0.914***
	(5.837)	(6.391)	(-3.179)	(4.813)	(3.365)
R^2	0.935	0.946	0.835	0.852	0.742
F	175.793	204.744	51.744	56.289	29.287
Significance	0.000	0.000	0.000	0.000	0.000

Note : **,5%; ***,1% level of significance.

Again, all the sample firms rely on overseas training as an important mode of learning. While in-house training was rated very important by all the firms except by firms using e-mail and the Internet, searching through the Internet emerged as significant only in firms using MIS. The relationship between learning by doing and firms using FMS emerged as significant, but negative. It is possible that MDs of firms using FMS strongly felt that learning by doing could not be an effective means of skill upgrading for firm-specific technologies such as FMS. A similar argument could explain the negative but significant relationship between firms using MIS and overseas training. Evidently, firms using MIS were not using e-business in production processes and hence they did not require overseas training for their workers.

Table 5.5 presents the parameter estimates and other statistics for Nigerian firms. The table shows that the types of e-business technology utilized by Nigerian firms are relatively more advanced (CAD/CAM) than Ugandan firms, but unlike some of the Indian firms sampled, the Nigerian firms were not using web- and portal-based e-business technologies.

Unlike Ugandan firms, the MDs of many of the Nigerian firms did not rate overseas training as an important source of knowledge

Table 5.5 Technological trajectories and learning processes (Nigeria)

Dependent variables	**Technologies**				
	CAD/CAM	**FMS**	**MIS**	**E-mail**	**Internet**
Training	0.507***	0.161	0.220	0.365 **	0.427***
	(3.187)	(1.185)	(1.324)	(2.040)	(2.879)
Learning by doing	−0.516***	−0.245 *	0.288 *	−0.289	−0.410 **
	(−3.212)	(−1.768)	(1.720)	(−1.577)	(−2.706)
Internet searching	0.106	0.560 ***	−0.015	−0.009	0.151
	(0.664)	(3.952)	(−0.088)	(−0.050)	(0.943)
Learning by interaction	0.060	0.184	0.125	0.267	0.149
	(0.450)	(1.360)	(0.801)	(1.523)	(0.934)
Overseas training	0.272 *	0.182	−0.172	0.272	0.419***
	(1.754)	(1.346)	(−1.055)	(1.545)	(2.789)
R^2	0.313	0.607	0.239	0.303	0.521
F	4.465	9.874	2.633	2.873	6.948
Significance	0.002	0.000	0.037	0.029	0.000

Note : *,10%; **,5%; ***,1% level of significance.

accumulation, although firms using CAD/CAM did consider it important. This is understandable because workers for firms using CAD/CAM would need special training that might not be available locally. The positive relationship between firms using the Internet and overseas training could also be because of the high probability that firms using the Internet are also likely users of CAD/CAM. Like the sample firms in the other two countries, MDs of Nigerian firms gave due importance to in-house training. Surprisingly the coefficient of learning by doing emerged significant but negative in all the regressions except firms using MIS. This could be because MDs of firms using advanced technology (FMS and CAD/CAM) did not consider learning by doing as an effective means of knowledge acquisition for this type of technology. This assumption was confirmed during our interviews where we found that firm owners who adopted advanced e-business techniques tend to have overseas affiliation and on-going technical collaboration with partners.

The results presented in the above tables suggest that, in general and across countries, learning by doing is indeed an important source of knowledge acquisition and accumulation. However, this mode of learning becomes less effective in cases where a firm adopts advanced technologies. Another significant result is that in the era of ICT-induced manufacturing revolution, MDs of sample firms in India have found that searching through the Internet is also an effective way of learning. This may be because industrial clusters from where the sample firms have been drawn enjoy relatively superior communication infrastructure. Consequently, MDs of these firms have found Internet searching to be a more reliable and rapid way of learning than organizing formal local and overseas training, and as important as the latter is for specific technologies. The reliable communications network promotes learning through interaction with other business partners. The emergence of learning by interaction as a significant mode among Indian firms illustrates the point.

The sample firms in Uganda and Nigeria, however, assigned more importance to training compared to searching through the Internet. The phenomenon can be explained by the same argument. Owing to lack of a reliable communications network, the sample firms in these countries prefer organized training as a viable alternative way of learning rather than Internet browsing. Whereas MDs of Indian firms depend less on overseas training, the sample firms in Uganda and Nigeria rate overseas training as a very important source of learning, although they do so for different technologies. This could be because in the last two decades, the Government of India has established several industrial clusters, wherein the private sector has been allowed to provide the needed technological

infrastructure, including human resource development institutions. Consequently, Indian firms would have less need for overseas training in advanced technologies than the other two countries.

5.5 Summary

This chapter investigated the differentiated effect of wider sets of firm-level skills on the learning processes in SMEs in the three developing countries. We distinguish a pattern of adoption that shows clear relationships between internal firm variables and external infrastructure features that influence both technological trajectories and firm-level performance. There is a certain gradation of adoption that displays skill-technology complementarity. There is net correlation between firms using advanced technologies and the education level of owners, and a consistent correlation between learning modes and complexity of ICTs in use. New types of SMEs, called networked enterprises, have emerged during the last decade (Raymond et al., 1999). However, our study suggests that this phenomenon is not automatic; there is a strong association between the complexity of firm-level e-technologies and the level of national technological capability (Oyelaran-Oyeyinka and Lal, 2004). Several scholars (Raymond et al., 1999; Blili and Raymond, 1993) have called attention to the threats and opportunities that come with the adoption of ICTs in SMEs. There is also considerable scope for institutional learning in SMEs, suggesting new and additional challenges for developing countries that, for now, have relatively weak institutions.

This chapter also examines whether the introduction of ICTs has induced changes to the technological trajectories of firms with data from India, Nigeria and Uganda. Regression analysis was used to identify the relationship between the learning processes adopted by the sample firms and technological trajectories followed by them. Several modes of learning such as in-house training, learning by doing, Internet searching, learning by interaction and overseas training were included in the analysis.

The results of the study suggest that across countries and sectors, SMEs have identified learning by doing as the most effective mode of knowledge acquisition, but the second choice of learning mode differs among sample countries. MDs of Indian firms employed Internet searching as the second best mode of learning, while in-house training was preferred in Nigeria and Uganda. We observe that the communications network facilities in Nigeria and Uganda are inadequate for effective use of the Internet and a reliable communications network significantly determines the use of the Internet. The study's findings also suggest that

firms that adopted complex technologies had to employ overseas training for effective use of such technologies. This finding is similar to other studies (Raymond et al., 1999; Blili and Raymond, 1993).

It is also found that learning processes have significantly influenced the technological trajectories of the firms, such as the sample firms in India adopting ICT-led technologies in production processes. We found several firms in India that were doing business through web-enabled and portal-based technologies, while there was not a single firm that adopted such advanced technologies in Nigeria and Uganda. We attribute two factors to the adoption of advanced technologies by Indian SMEs: the accessibility of stable Internet connectivity and the availability of requisite technological infrastructure in clusters where the sample firms were located. Reliable access to the Internet might have encouraged Indian SMEs in the sample to use Internet searching as the second best mode of learning. In contrast, the sample firms in Nigeria and Uganda adopted technologies that do not require online connectivity such as MIS, e-mail, CAD/CAM, CNC machines and FMS; and hence, their dependence on a strong communications network is not very high. This leads us to conclude that learning process significantly influenced the technological profile of firms. To this end, the choice of learning processes depends on other external factors that are beyond the control of individual firms.

The study suggests several policy implications. First, SMEs need institutional support for their survival in the era of globalization. Second, human development policies aimed at SMEs need to emphasize both general and specific knowledge types and training; the adoption of advanced e-business technologies by Indian SMEs is a proof of this point. GOI and the private sector shared the burden and the risk as the GOI encouraged private sector participation in the development of the industrial clusters' technological infrastructure. Consequently, SMEs in India have better access to web-enabled and portal-based e-business technologies relative to the two African countries. However, the GOI still has to take initiative for providing uninterrupted utility services so that SMEs can become more competitive in international markets. Finally, the study suggests that SMEs in Nigeria and Uganda need much greater infrastructural support in order to reap the benefits of ICTs and develop the capabilities to contribute to economic development. Proper policies and programmes aimed at providing required infrastructure need to be initiated in developing countries in order to make SMEs in developing countries more competitive in the domestic and international markets.

The next chapter explores the infrastructural dimensions in greater detail.

Appendix A Learning processes and types of e-business technologies

E-business technologies	Learning mode					
	Training	Learning by doing	Internet searching	Learning by interaction	Overseas training	Total users
India						
FMS	4	5	5	5	5	5
	(80.00)	(100.00)	(100.00)	(100.00)	(100.00)	
MIS	152	214	186	158	143	228
	(66.67)	(93.86)	(81.58)	(69.30)	(62.72)	
E-mail	122	167	144	122	110	175
	(69.71)	(95.43)	(82.29)	(69.71)	(62.86)	
Web site	48	73	64	57	57	76
	(63.16)	(96.05)	(84.21)	(75.00)	(75.00)	
Portal	22	23	22	24	21	25
	(88.00)	(92.00)	(88.00)	(96.00)	(84.00)	
Total firms	231	231	231	231	231	231
Uganda						
CNC	20	16	19	19	19	21
	(95.24)	(76.19)	(90.48)	(90.48)	(90.48)	
FMS	20	15	19	19	19	21
	(95.24)	(71.43)	(90.48)	(90.48)	(90.48)	
MIS	25	21	19	21	18	28
	(89.29)	(75.00)	(67.86)	(75.00)	(64.29)	

(*Continued*)

Appendix A (*Continued*)

E-business technologies	Learning mode					
	Training	Learning by doing	Internet searching	Learning by interaction	Overseas training	Total users
E-mail	17 (89.47)	14 (73.68)	16 (84.21)	17 (89.47)	17 (89.47)	19
Internet	19 (86.36)	15 (68.18)	18 (81.82)	17 (77.27)	17 (77.27)	22
Total firms	84	84	84	84	84	84
Nigeria						
CAD/CAM	7 (100.00)	4 (57.14)	2 (28.57)	4 (57.14)	2 (28.57)	7
FMS	6 (100.00)	4 (66.67)	3 (50.00)	4 (66.67)	2 (33.33)	6
MIS	28 (87.50)	29 (90.63)	2 (6.25)	13 (40.63)	1 (3.13)	32
E-mail	14 (82.35)	12 (70.59)	3 (17.65)	10 (58.82)	3 (17.65)	17
Internet	8 (100.00)	5 (62.50)	3 (37.50)	5 (62.50)	3 (37.50)	8
Total firms	105	105	105	105	105	105

Note: Figures in parentheses are row percentages. Percentages are not expected to add to 100 per cent because of multi-response of MDs.

6
Institutional Infrastructure Supporting E-Business Adoption

6.1. Introduction

Infrastructure is fundamental to all production activities, and a network function, be it telephony or electricity, depends on massive physical and technological infrastructure, which traditionally had been supplied by public monopolies. However, the required scale of investment for a modern infrastructure is often beyond the financial capacity of private investors in developing countries. Infrastructure possesses technical and economic characteristics that affect innovation XE "innovation" systems in very profound ways. The technical attributes of infrastructure include 'scale, indivisibility, multiple use and generic functions' that separate it from other forms of capital.[14] Indivisibility confers a systemic attribute on infrastructure that allows it to serve the entire industrial and non-industrial system, with considerable flexibility for multiple extensions. The latitude for multiple use of infrastructure by urban and non-urban consumers equally extends its scale-economic characteristics. In this chapter, we consider three categories of infrastructure: physical, technological and human capital infrastructure.

The main objective of the chapter is to identify and analyse supply side factors that influence the adoption of e-business by SMEs. These factors mainly represented technological infrastructure available to SMEs. In addition to constituting the majority of business organizations, SMEs were selected for the study as they are a major source of employment and foreign exchange in all the countries.

The remainder of the chapter is organized as follows: Section 6.2 discusses data sources and measurement of e-business technology intensity. In Section 6.3, we formulate hypotheses and present the analytical

framework used in the study. Statistical results are analysed and discussed in Section 6.4 while Section 6.5 contains the chapter summary.

6.2 Data Sources and Measurement Issues

We analysed data for the three countries separately because their needs and capacity for technological absorption differ significantly. In addition, the intensity of adoption of e-business tools differs considerably in each country; for this reason, a common unit of analysis could not be used. The survey found that firms use e-business technologies in production as well as in other activities such as marketing, co-ordination and after sales support. The tools used in production processes were CAD/CAM, CIM, FMS, and CNC. Firms were using e-mail, Internet, and web-enabled and portal-based technologies for transaction processing and co-ordination of activities. Almost all the sample firms in India were using office automation technologies such as MIS and LAN.

As mentioned earlier, the type of e-business tools used by sample firms vary significantly across countries. Hence, it was not possible to use the same scale of measurement of e-business intensity. For instance, many Indian sample firms were using web-enabled and portal-based technologies, whereas not a single firm in Nigeria and Uganda was using these technologies. However, firms were grouped based on the type of e-business technology they used. Indian firms were classified into three groups: the first group use e-mail and office automation technologies, the second group have adopted office automation tools as well as new technologies in production processes and the last group adopted e-mail, office automation tools, e-business technologies in production processes, and were users of web- enabled and portal-based technologies. In this way, we generated an ordinal-ranked variable that represent the group identification of firms.

We ranked firms in the other two countries similarly. The majority of sample firms were using telephone and fax machines as means of communication. Hence, in Uganda and Nigeria, the lowest group of firms are those that had telephone and fax machines only. The second category includes firms that adopted e-mail and office automation tools, while the third group used e-business tools in production processes in addition to e-mail and office automation. The fourth category includes those firms that were using the Internet in addition to the technologies used by the third category of firms.

6.3 Hypotheses and Analytical Framework

This study measures the explanatory variables on a five-point scale. The variables are Internet accessibility problem, speed of Internet, lack of skilled workforce, power supply problem, cost of communication and Internet subscription fee. A value of '1' was assigned when MD of firms reported that a particular factor was not a constraint and a value of '5' was assigned when a factor was reported to be a severe constraint. Values '2', '3' and '4' were assigned when the qualitative responses were 'constraint to some extent', 'Yes' and 'serious constraint' respectively. The same method of converting qualitative responses to numeric values was used in all the three countries.

6.3.1 Hypotheses

The three institutional supply side factors examined in the study are technological infrastructure, physical infrastructure and human resources. These variables have been analysed by several scholars (Hargittai, 1999; Ishii, 2004, Lam et al., 2004, Berkhout and Hertin, 2004), but in different contexts. Our hypotheses regarding these variables and the adoption of e-business technologies by SMEs are presented under three different infrastructural categorizations.

6.3.1.1 Technological Infrastructure

Technological infrastructure encompasses several factors, and they are specific to a particular technology. Deriving from the objectives of the study, we discuss the supply side factors that foster the diffusion of e-business technologies. They revolve largely around the quality, quantity and cost of communications network. We also include cost of the Internet subscription, a driving force behind the diffusion of the Internet and e-business technologies. In the context of communications networks, the study by Ishii (2004) suggests that both mobile connectivity and fixed telephone connectivity have played a complementary role in the diffusion of the Internet. The author found that while most people use e-mail from a mobile network, the web-enabled applications are carried out by fixed line connectivity in Japan. The study suggests that the cost of Internet server density and that of communication has played an important role in the diffusion of the Internet. However, a study by Berkhout and Hertin (2004) suggests that the adoption of ICTs has positive impact on production processes, products and distribution systems. The authors also found that communications infrastructure is a major factor in the diffusion of ICTs.

Another study by Lam et al. (2004) suggests that technological infrastructure and Internet costs are very relevant for Internet diffusion in Vietnam. However, the authors found a slightly elongated S-curve growth pattern during 1997–2002. They also attributed socio-legal and political factors for low level of Internet diffusion. This constraining influence confirms the Northian view of institutions as 'the humanly devised constraints that structure political, economic and social interactions' (North, 1990, p. 1). Another study by Oyelaran-Oyeyinka and Adeya (2004) also found that teledensity significantly influenced Internet diffusion in Africa.

The main effect of poor infrastructure is the high average cost of access to the Internet. In a study of the differential connectivity within the OECD, Paltridge (2001) identifies pricing structure as an important factor for access to electronic commerce and the Internet. Cost components include local call charges, line rentals charges and costs of ISP services, but telecommunications regulation, the wealth of a nation, and the presence of commercial access providers are other important predictors of Internet access, (Paltridge, 2001). Poor countries have relatively inferior ICT infrastructure and predictably lower quality connectivity. Given that Internet-enabled technologies are the main constituents of e-business tools, we hypothesise that communications infrastructure and associated costs are likely to have similar impacts on e-business technologies adoption as on the Internet.

6.3.1.2 Physical Infrastructure

Although physical infrastructure consists of several components such as transport, power and other utilities, this study limits itself to an investigation of the role of power supply on the adoption of new technologies. Although steady power supply has a critical role to play in all industrial activities, very little is known of its impact in the diffusion of e-business technologies that do not require much power at the end user. Traditionally, end users have attenuated the disruptive effect of power outages by employing temporary storage power sources, but this solution has its limits. For instance, most users of e-mail and the Internet can run their equipment on an UPS system of 500 V per system in the event of power failure. However, if the firm is online and connected to business partners, it may require UPS of a much bigger capacity. Moreover, given the nature of the sample firms (SMEs), UPS of higher capacity may not be economically viable. Power supply was found to be an important determinant of the diffusion of the Internet in Africa (Oyelaran-Oyeyinka and Adeya, 2004). We also expect that a

temporary solution, such as UPS, may not be an appropriate solution to frequent power failures, as it does not make for effective use of e-business tools.

6.3.1.3 Human Resources

Knowledge and its effective use have always affected the development process, and in an innovation-driven global economy, it has assumed a pivotal place in traditional sectors as well as those termed high-tech. The emergence of ICTs has introduced a new and qualitative dimension to the knowledge and skills requirements of production. This is largely due to the innovation's character of skill-biased technological change by which higher technical skills and knowledge tend to find greater complementarities with physical labour than uneducated or unskilled labour (Doms et al., 1997). Several studies (Lal, 2004; Hargittai, 1999) have investigated the impact of skill intensity on the diffusion of ICTs. Lal's (2004) study suggests that advanced users of ICTs require highly skilled persons to use them effectively. Unlike Lal's (2004) study dealing with ICT adoption and export performance of firms in developing countries, Hargittai's (1999) study used data from OCED countries to examine the factors that influenced the diffusion of the Internet. The study finds evidence to support the argument that literacy rate is an important determinant of the diffusion of the Internet.

We therefore hypothesize that lack of skilled labour would be a constraint in the adoption of e-business.

6.3.2 Analytical Framework

Until recently, the debate about the different factors that influence the innovation strategy of large corporations and SMEs were very different. However, in the era of widespread economic liberalization, the faster integration of dynamic SMEs into the global economy relative to the slower process of globalization of small producers in poorer developing countries has become an important subject. Although they do so with different internal technological and other assets, both large and small firms face substantially similar technological and external economic conditions. In addition, local, regional and global policies influence the conduct and performance of SMEs. A framework linking these factors and the performance of SMEs is depicted in Figure 6.1. Since the objective of the study is to understand the institutional infrastructure factors affecting the adoption of e-business – importantly by telecommunications policies – the analytical framework focuses mainly on policies related to this sector.

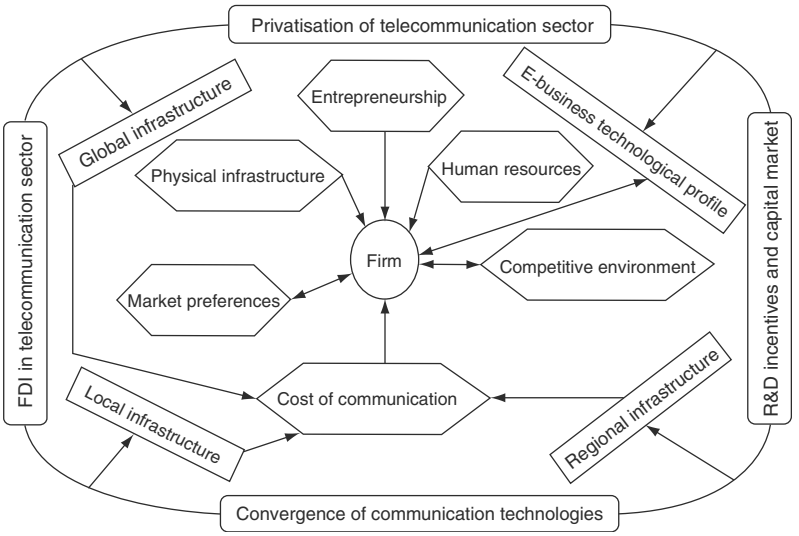

Figure 6.1 Analytical framework

As figure 6.1 shows, the attraction of FDI in telecommunications sector coupled with privatization is expected to bring drastic changes in a country's communications network. While the formulation and implementation of effective FDI policies are expected to foster the acquisition of the latest technologies, a liberalized market is expected to, at a competitive price, augment accessibility of the communications network. These are very important market considerations for SMEs, since affordability of new technology is a major issue in economies prone to technology market failures. Although several other issues, such as technology convergence and R&D incentive, are included in the framework, they are not discussed here in detail, as their effect cannot be examined due to lack of data.

Apart from communications technology policies, other factors also influence the adoption of new technologies, including the competitive environment (Pratten, 1991), skill composition of the workforce (Doms et al., 1997), market preferences (Lal, 2004), cost of communication (Mehta, 2000) and entrepreneurship (Drew, 2003). However, we limit our discussion to the factors that are external to firms which are: technological infrastructure, human resources, and physical infrastructure available to SMEs. In other words, we focus our discussion on the supply side factors that influence the adoption of e-business technologies,

which differ from other innovations in many respects (Pohjola, 2001). For instance, its economy-wide pervasiveness means that it involves a wide array of actors and as such exerts profound systemic impact on national economies. These actors include communication technology providers, Internet service providers and information providers. The costs associated with communication network, Internet services and availability of information in public domain are some of the other factors that influence the diffusion of e-business technologies.

Another significant aspect of e-business technologies is the network speed. This has two main components: the speed with which signals can travel along the communications network and the speed of information processing systems (servers subsequently). Although the capabilities of the information processing servers installed at local, regional and national level determine the network speed, the major factor is the processing speed of the immediate Internet service provider. For these reasons, the adoption of e-business technologies encompasses several factors, including a reliable high bandwidth communications network, competitive telecom services and an available quantity of quality Internet service providers. Also, as the force of competition tends to shape the attitude of enterprises to the adoption of innovations, the level of competitiveness of firms operating in the same product market is another factor influencing the e-business technologies adoption. Although much has been written about the broad impact of physical infrastructure and human resources on innovation, they are likely to affect the adoption of e-business technologies in very specific ways. The data collected are analysed within the framework in Fig. 5 and the results are presented and discussed in the sections following.

6.4 Statistical Analysis

The data were first analysed by examining the bivariate distribution of firms. The associations of the level of e-business technology adopted by the sample firms and the opinion of MDs regarding supply side factors are presented in Tables 6.1–6.7. Table 6.2 presents the distribution of firms by the type of e-business technology used and the opinion of MDs relating to ease of accessibility of the Internet.

Results presented in Table 6.1 suggest that most Indian sample firms do not consider accessibility to the Internet a constraint, while the opinions of MDs of firms in the other two countries are totally different. Although only nine Nigerian firms registered their response to this constraint, all the firms reported accessibility as a serious or severe problem.

Table 6.1 Internet service providers and e-business

Intensity of e-business	Indicator					
	Is access to the internet a constraint?					χ^2(Significance)
	No	To some extent	Yes	Serious	Severe	
India						11.009 [0.001]
EB_eo	13 (52.0)	4 (16.0)	2 (8.0)		6 (24.0)	25
EB_p	13 (35.1)	5 (13.5)	6 (16.2)	6 (16.2)	7 (18.9)	37
EB_pu	119 (70.4)	13 (7.7)	14 (8.3)	15 (8.9)	8 (4.7)	169
Nigeria						6.367 [0.012]
EB_tf				1 (100.0)		
EB_eo				3		
					(100.0)	
EB_p					2 (100.0)	
EB_i					3 (100.0)	
Uganda						4.321 [0.038]
EB_tf	2 (5.6)	7 (19.4)	8 (22.2)	10 (27.8)	9 (25.0)	36
EB_eo	1 (14.3)		3 (42.9)	1 (14.3)	2 (28.6)	7
EB_p			1 (33.3)	2 (66.7)		3
EB_i	9 (37.5)	6 (25.0)	2 (8.3)	4 (16.7)	3 (12.5)	24

Note: Figures in parentheses are row percentages, while figures in square brackets are level of significance of χ^2statistics.

Also, although 75 per cent of Ugandan sample firms used only telephones and fax machines, they reported difficulty in Internet access as a major factor for not using it. However, this percentage reduced to 37.5 per cent in the category of Ugandan sample firms that were using the Internet. The percentage of firms that found Internet accessibility a

Table 6.2 Communications infrastructure and e-business

Intensity of e-business	**Indicator**					
	Is speed of communication a constraint?					χ^2**(Significance)**
	No	**To some extent**	**Yes**	**Serious**	**Severe**	
India						4.739 [0.029]
EB_eo	9 (36.0)	3 (12.0)	3 (12.0)	3 (12.0)	7 (28.0)	25
EB_p	16 (43.2)	5 (13.5)	7 (18.9)	6 (16.2)	3 (8.1)	37
EB_pu	95 (56.2)	16 (9.5)	18 (10.7)	21 (12.4)	19 (11.2)	169
Nigeria						0.942 [0.332]
EB_tf					2 (100.0)	2
EB_eo				2 (28.6)	5 (71.4)	7
EB_p				1 (50.0)	1 (50.0)	2
EB_i				1 (33.3)	2 (66.7)	3
Uganda						1.158 [0.282]
EB_tf	2 (5.6)	2 (5.6)	6 (16.7)	2 (5.6)	24 (66.7)	36
EB_eo	2 (28.6)	1 (14.3)	2 (28.6)		2 (28.6)	7
EB_p	1 (33.3)	1 (33.3)	1 (33.3)			3
EB_i	2 (8.3)	1 (4.2)	9 (37.5)	2 (8.3)	10 (41.7)	24

Note: Figures in parentheses are row percentages, while figures in square brackets are level of significance of χ^2 statistics.

problem varies from 85.7 to 100 per cent in other categories of firms using e-business technology. The results suggest that most Indian sample firms did not find access to the Internet a problem, while it is a serious problem in the other two African countries. It is important to note that the relationship between the opinions on Internet accessibility and the degree of e-business technology adoption is at 1 per cent level of

Table 6.3 Human resources and e-business

Intensity of e-business	Indicator					
	Is computer literacy a constraint?					χ^2(Significance)
	No	To some extent	Yes	Serious	Severe	
India						0.436 [0.509]
EB_eo	13 (48.1)	4 (14.81)	3 (11)	2 (7.4)	5 (18.51)	27
EB_p	24 (64.9)	3 (8.1)	4 (10.8)	4 (10.8)	2 (5.4)	37
EB_pu	107 (63.3)	17 (10.1)	18 (10.7)	13 (7.7)	14 (8.3)	169
Nigeria						0.215 [0.643]
EB_tf					7 (100.0)	7
EB_eo	2 (11.8)				15 (88.2)	17
EB_p					16 (100.0)	16
EB_i	2 (40.0)				3 (60.0)	5
Uganda						8.861 [0.003]
EB_tf	5 (13.9)	8 (22.2)	5 (13.9)	10 (27.8)	8 (22.2)	36
EB_eo		3 (42.8)	1 (14.3)	1 (14.3)	2 (28.6)	7
EB_p	1 (33.3)		1 (33.3)	1 (33.3)		3
EB_i	11 (45.8)	1 (4.2)	1 (4.2)	9 (37.5)	2 (8.3)	24

Note: Figures in parentheses are row percentages, while figures in square brackets are level of significance of χ^2statistics.

significance in India and Nigeria while the level of significance is 5 per cent in the case of Uganda.

The more conducive technological environment in India is due to the robust competitive regime for Internet services and the availability of large numbers of ISPs. According to a World Bank (2004) study which measured the competitiveness of ISPs on a seven-point scale (seven is

Table 6.4 Physical infrastructure and e-business

Intensity of e-business	**Indicator**					
	Is power supply a constraint?					χ^2**(Significance)**
	No	**To some extent**	**Yes**	**Serious**	**Severe**	
India						11.331 [0.001]
EB_eo	1	3	3	13	5	25
	(4.0)	(12.0)	(12.0)	(52.0)	(20.0)	
EB_p	11	6	11	4	5	37
	(29.7)	(16.2)	(29.7)	(10.8)	(13.5)	
EB_pu	52	28	44	32	13	169
	(30.8)	(16.6)	(26.0)	(18.9)	(7.7)	
Nigeria						1.680 [0.195]
EB_tf	2				4	6
	(33.3)				(66.7)	
EB_eo	2				15	17
	(11.8)				(88.2)	
EB_p	3				18	21
	(14.3)				(85.7)	
EB_i	1				5	6
	(16.7)				(83.3)	
Uganda						5.999 [0.014]
EB-tf		6	8	12	9	35
		(17.1)	(22.9)	(34.3)	(25.7)	
EB_eo		2	3	2		7
		(28.6)	(42.9)	(28.6)		
EB_p	1			2		3
	(33.3)			(66.7)		
EB_i	5	6	6	4	3	24
	(20.8)	(25.0)	(25.0)	(16.7)	(12.5)	

Note: Figures in parentheses are row percentages, while figures in square brackets are level of significance of χ^2 statistics.

highest), the competition in ISPs was found to be 4.5 in the year 2002 in India, while the index for Nigeria was 3.7. The study also reported that in 2002, the number of Internet users in India was 7,000,000 persons, while in Nigeria and Uganda there were 115,000 and 60,000 users respectively. Although there is a circular effect in the ease of accessibility to the Internet and the number of users, the large numbers of users in India indicate relatively easy access. Extending this argument, the low number of users in Nigeria and Uganda are a reflection of a condition of poor Internet accessibility. The similar pattern of poor firm-level

Table 6.5 Communications cost and e-business

Intensity of e-business	Indicator					
	Is cost of communication a constraint?					χ^2(Significance)
	No	To some extent	Yes	Serious	Severe	
India						3.283 [0.070]
EB_eo	4	7	3	3	8	25
	(16.0)	(28.0)	(12.0)	(12.0)	(32.0)	
EB_p	6	7	8	7	9	37
	(16.2)	(18.9)	(21.6)	(18.9)	(24.3)	
EB_pu	49	28	35	32	25	169
	(29.0)	(16.6)	(20.7)	(18.9)	(14.8)	
Nigeria						4.208 [0.040]
EB_tf	5				4	9
	(55.6)				(44.4)	
EB_eo	16				2	18
	(88.9)				(11.1)	
EB_p	17				3	20
	(85.0)				(15.0)	
EB_i	5				1	6
	(83.3)				(16.7)	
Uganda						3.555 [0.059]
EB_tf	5	5	8	6	12	36
	(13.9)	(13.9)	(22.2)	(16.7)	(33.3)	
EB_eo	1	1	3	1	1	7
	(14.3)	(14.3)	(42.8)	(14.3)	(14.3)	
EB_p	1	1	1			3
	(33.3)	(33.3)	(33.3)			
EB_i	8	2	7	4	3	24
	(33.3)	(8.3)	(29.2)	(16.7)	(12.5)	

Note: Figures in parentheses are row percentages, while figures in square brackets are level of significance of χ^2 statistics.

access is reflected in the national level IUI of 0.023 and 0.024 for Uganda and Nigeria respectively.

Table 6.2 presents the distribution of firms by Internet speed and the degree of e-business technologies adoption. The results are very different in the three countries. Over 60 per cent of Indian firms that adopted e-mail and office automation technologies did not adopt web-based technologies due to very low Internet connection speeds. This percentage reduces to 56.8 per cent for those that were using e-business technologies

Table 6.6 Technological infrastructure capability and e-business adoption

Intensity of e-business	**Indicator**					
	Is internet subscription fee a constraint?					χ^2**(Significance)**
	No	**To some extent**	**Yes**	**Serious**	**Severe**	
India						3.029 [0.082]
EB_eo	10 (40.0)	4 (16.0)	2 (8.0)	3 (12.0)	6 (24.0)	25
EB_p	22 (59.5)	3 (8.1)	3 (8.1)	5 (13.5)	4 (10.8)	37
EB_pu	105 (62.1)	13 (7.7)	12 (7.1)	21 (12.4)	18 (10.7)	169
Nigeria						6.076 [0.014]
EB_tf					3 (100.0)	
EB_eo	2 (66.7)				1 (33.3)	
EB_p	1 (50.0)				1 (50.0)	
EB_i	2 (100.0)					
Uganda						1.867 [0.172]
EB_tf	11 (30.6)	3 (8.3)	12 (33.3)	6 (16.7)	4 (11.1)	36
EB_eo	1 (14.3)		1 (14.3)	4 (57.1)	1 (14.3)	7
EB_p			2 (66.7)	1 (33.3)		3
EB_i	2 (8.4)	5 (20.8)	6 (25.0)	6 (25.0)	5 (20.8)	24

Note: Figures in parentheses are row percentages, while figures in square brackets are level of significance of χ^2 statistics.

in production processes, although the difference is not too significant. Among the firms that were using Internet and web-enabled technologies, 23.6 per cent of such firms reported that they faced serious or severe problem in using these technologies due to the low speed of the communications network. Use of web-enabled technologies may be imperative for such firms, but they could not afford to access high-speed communications technologies. However, 56.2 per cent of advanced

Table 6.7 Ordered probit results

Dependent variable: Intensity of e-business adoption	
Independent variables	**Coefficient (Significant)**
Availability of Internet Connection	−0.276*** (−4.036)
Speed of Connection	−0.149** (−2.334)
Computer Skill	−0.042 (−0.601)
Availability of Power Supply	−0.220*** (−2.858)
Cost of access	−0.112* (−1.793)
Internet Subscription Cost	−0.153** (−2.561)
Log Likelihood Function	−156.62
Significance	0.000

Note: Figures in parenthesis are *t*-values.
*** Significant at 1 per cent.
**Significant at 5 per cent.
*Significant at 10 per cent.

e-business technologies users did not find speed a constraint in using Internet and other related technologies, although these firms may have enough financial resources at their disposal to access dedicated digital communications lines for their business activities.

The table shows that speed of the Internet has been a serious problem for Nigerian firms. However, the relationship between the opinion about Internet speed and the use of new technology is statistically insignificant. Although this relationship is insignificant in Uganda as well, the opinions of MDs vary significantly among different type of firms using e-business technology. Over 70 per cent of firms using fax and telephone reported that they did not adopt these technologies because speed of the Internet was serious or severe problem and more than 50 per cent of firms using e-mail expressed similar views. Among the actual users of the Internet, only 8.3 per cent of firms did not find speed a constraint for Internet use. These results suggest that speed of the Internet has been a bottleneck in the diffusion of the web-enabled e-business technologies.

One of the possible reasons for not reporting speed as a problem by most of the advanced e-business technology firms could be that they could afford high-speed communication networks due to greater financial resources as compared to poorer firms. Moreover, the use of new technology may be a competitive necessity as most of them were export-oriented firms. In general, Indian firms have reported that speed has not been a major constraint. This may also be attributed to the fact that their telecommunications network is reasonably better than in the

other two countries. The World Bank (2004) report suggests that broadband Internet access availability was at 3.2 on a seven-point scale in 2002. Although the broadband Internet accessibility index (3.1) in Nigeria was similar (World Bank, 2004), all the Nigerian sample firms reported that speed was a very severe constraint. As Internet access speed consists of the speed of the communications network as well as processing speed and the number of servers with ISPs, the low density of Internet servers in Nigeria and Uganda might well be the major reason for poor provision of Internet services.

Results related to the impact of human resource policies proxied by availability of skilled computer labour are presented in Table 6.3. Although most of the Indian sample firms reported that availability of trained labour has not been an impediment in the adoption of new technologies, the relationship, however, is statistically insignificant.

In contrast, most of the firms in Nigeria found that the availability of skilled labour has been a severe problem. However, the association between availability of workers with requisite skills and the adoption of e-business technologies is statistically insignificant. Surprisingly, 40 per cent Nigerian sample firms that use the Internet reported that availability of computer literate labour has never been a constraint in the adoption of new technologies. Although sample firms in Uganda faced the institutional support environment as Nigeria, the relationship is statistically significant. Over 50 per cent of the Ugandan MDs in all categories of firms using e-business technology faced problems in getting trained labour.

It is not surprising that most Indian sample firms did not find human resources a constraint because of the availability of a large pool of computer-trained workforce. Governments and private institutions have contributed substantially in producing a skilled work force. In addition, a number of industrial clusters are well equipped with training institutions that provide job-specific trainings, which may not be the case in Nigeria and Uganda. Using the number of scientists and engineers in R&D to indicate the availability of skilled workforce, India had 157.2 persons per million people in 2002 or seven times that of Uganda which had only 23.6 persons per million people (World Bank, 2004). This gap in scientists and engineers is a reflection of the qualitative difference in technological institutions responsible for producing computer-trained workers. Nigeria, well known for producing scientists and engineers, has been less successful in organizing formally trained workers for industrial purposes. Despite establishing a number of private training institutes, the types of institutional support available to small enterprises in India, such as subsidies for training, is absent in Nigeria. This suggests that the

poor incentive system combined with relatively fewer numbers of training institutions has been a major limitation in producing required technical work force, which has resulted in severe constraint in the diffusion of e-business in Uganda and Nigeria.

Poor quality of physical infrastructure has been a major problem in the industrialization of developing countries. Since sample firms in all the countries were located in industrial clusters, we solicited the opinion of MDs on the availability of power supply. We expected the various countries' governments to have provided a better power supply within the industrial clusters in order to make SMEs internationally competitive. However, controlling for countries, the results do not show that to be true. In the case of Indian sample firms, 72 per cent of firms using e-mail reported that power supply has been a serious or severe problem in the adoption of e-business technologies. Yet a smaller proportion of the Indian firms using more advanced e-business technology reported power supply as a major problem. Again, advanced e-business firms tend to have better resources to provide alternative power facilities to make up for poor public supply.

The pattern in the other two countries is similar. While 66.7 per cent of Nigerian firms using telephone and fax found power supply a crucial factor, this has been severe problem for 83.3 per cent of firms using the Internet. This trend is different from that found for Indian sample firms, where the percentage of advanced e-business technology users that found power supply a major problem was far less than compared to others that did not. Although results for Ugandan firms are similar to that of Nigeria, in Nigeria the relationship is insignificant while it is significant at 5 per cent level in Ugandan sample firms.

We have also tried to capture the role of competitiveness in the telecom sector on the diffusion of new technologies. Competitiveness is expected to induce higher product and service quality, as well as to lower prices. We sought the opinion of MDs on the cost effect of communications as a constraint. The results are presented in Table 6.5. Although the association between the adoption of new technologies and cost of communications is statistically significant in all the countries, the opinion varies drastically among sample countries.

A small percentage of Indian firms (between 16 and 29 per cent) did not consider cost of communications a constraint in the adoption new technologies. While 32 per cent of firms using e-mail and office automation technology found cost to be a severe constraint, only 14.8 per cent of firms using portal and web-enabled technology shared the same view. The results suggest that a smaller percentage of firms using advanced

technology encountered cost as a constraint than those using low technology. Although the Ugandan firms had a similar experience as that of Indian firms with regard to adoption of new technologies and the cost of communications, the results of Nigerian firms seem very strange.

In Nigeria, poor power supply has become an accepted fact of daily and industrial life. Firms no longer regard this as an issue except for the cost of securing alternative provision. The majority of sample firms (83.3–88.9 per cent) that adopted communications technology's intensive e-business tools did not find cost of communications as a constraint, although firms that had not adopted intensive e-business tools had found cost a severe constraint. No opinion was expressed between some constraint and serious constraint.

Data presented in World Bank (2004) report partly explain the opinion expressed by the MDs of sample firms. According to the report, India had 38 fixed telephone lines per 1000 people in 2002. As most of the sample SMEs use telephone lines as the preferred mode of Internet communications and as analogue communications is not sufficient for transferring hypertext, most Indian firms have found communications a major constraint. However, their position is better when compared to that of Nigeria and Uganda. In 2001, there were only 5 telephone lines per 1000 people in Nigeria and just 3 per 1000 people in Uganda (World Bank, 2004).[15] Despite having low telephone density, many firms in Nigeria and Uganda did not find communications an impediment in adopting new technologies. Comparatively, more Ugandan firms than Nigerian found communications cost a major constraint. This may be due to the less expensive telephone usage charges in Nigeria (USD 0.57) than in Uganda (USD 0.82) in 2001(World Bank, 2004).

Finally, we examined the association between the adoption of new technologies and the technological infrastructure capability (TIC) of the countries, using Internet subscription fee as a proxy for TIC. We considered Internet subscription fee as the most appropriate proxy because it reflects the competitiveness of the Internet service providing industry as well as the government policies that are responsible for local, regional and global communications infrastructure. Table 6.6 presents the results, and as observed from the table, the results differ across countries.

While the association between new technologies adoption and cost of the Internet is statistically insignificant in Uganda, it is significant at 5 per cent and 10 per cent levels in Nigeria and India respectively. A large percentage (62.1 per cent) of Indian firms using portal and web-enabled e-business technology reported that Internet fee was not a constraint, although 23.1 per cent of Indian firms using advanced e-business

technology did state that the fee was a serious or severe constraint. An even greater percentage (36 per cent) of Indian firms using e-mail considered fee a major constraint in the use of web-enabled e-business technologies. Again, Nigerian firms show a very peculiar behaviour; more than 50 per cent of firms found that subscription fee was not a constraint whereas the remaining sample firms did not use the Internet because they considered the subscription fee a severe constraint. The situation in Uganda is very different. Unlike India and Nigeria, the SMEs in Uganda reported that Internet subscription fee was a major constraint in the adoption of web-enabled e-business technologies. A large percent (71.4 per cent) of firms using e-mail did not adopt the Internet because of very high subscription cost while 45.8 per cent of firms using the Internet also either found that subscription was a serious or a severe constraint.

Subsequently, we carried out a multivariate analysis. Ordered probit regression analysis was preferred over OLS estimates because the dependent variable, the intensity of e-business technology adopted by the firms, is a discrete and ranked variable. The multivariate analysis is limited to Indian sample firms only because we had an insufficient number of observations for probit analysis for Nigerian and Ugandan data. Multivariate analysis results presented in Table 6.7 show that they are similar to what we obtained in the bivariate analysis. However, all the factors included in the analysis, except human capital, emerged significant with negative sign. The results show that skilled human capital has not been a constraint for the diffusion of e-business technologies in Indian firm. This is not surprising because, as we observed earlier, India has a comparatively large pool of engineers and scientists. Although the use of e-business technologies does not require scientists and engineers, this is certainly an indicator of availability of skilled workforce.

The reason for the negative signs on all the coefficients is the way the variables are measured. The highest value was assigned to the most advanced users of new technologies, which means the e-business intensity variable (dependent) got the highest value for most advanced users of e-business technology. The independent variables were measured on a five-point scale by assigning '1' to 'factor is not a constraint' and '5' to 'severe constraint'. Several firms using advanced e-business technology responded with '1' for most of the independent variables while independent variables had a value of '3' for all such firms. This is because firms using advanced e-business technology usually have a higher scale of operation and, even at higher costs, are better placed to adopt new technologies. Hence, they reported that supply side factors were not major constraints. This may not be true for smaller firms with low level

of e-business adoption that consequently reported that supply side factors were major constraints. Hence, higher values to independent variables were assigned while their rank based on e-business technology was low. There is clearly an inverse relationship in the magnitude of independent and dependent variables. Consequently, the coefficients of all the variables are negative.

The results presented in Table 6.7 show that the availability of Internet connectivity emerged the most significant variable to influence the adoption of e-business tools in Indian SMEs. This is expected, given India's emergence as a major world player in software products and services in recent times. Severe competition in the domestic market has resulted in widespread accessibility of the Internet services, and several Internet service–providing companies have set up their service centres within SME clusters. For this reason, SMEs with relatively larger size of operation might not have encountered any problem in accessing Internet services even if it comes at a higher price.

The speed of communications also emerged as a significant factor influencing the adoption of new technologies. Although the GOI has taken several measures to provide communications services at internationally competitive prices, the digital communications network is still out of the reach of very small firms. Communications services, such as PSTN, integrated service digital network (ISDN), asymmetric digital subscriber loop (ADSL), are available in India, however, many SMEs cannot afford digital networks and so they rely on low-speed analogue communications. The emergence of communications cost as an important factor influencing the adoption of e-business technologies substantiates this argument.

The other two supply side factors that have bearing on the adoption of new technologies are the availability of power supply and Internet subscription fee. A regular and reliable power supply reflects sound physical infrastructure, which is ordinarily provided as part of public goods. Although privatization of power distribution has started in India, its impact has yet to show. Consequently, power supply could remain a major impediment for relatively smaller firms that cannot provide alternative facilities. The same argument extends to Internet subscription fees. Although the fee alone may not constitute a constraint for Indian firms due to the sector's highly competitive environment, effectively it becomes very costly when the Internet access speed is too slow and the communications network is not reliable. The emergence of the Internet subscription fee as a significant constraint may be partly due to low communications speed that indirectly increases the subscription fee.

6.5 Summary

The chapter analyses the impact of supply side factors on the adoption of new technologies in SMEs in India, Nigeria and Uganda using e-business technologies as a proxy for new technologies. Primary data collected from manufacturing firms located in these three countries form the basis of the study. The results suggest that availability of physical infrastructure has been a severe constraint in the adoption of e-business technologies in all three countries whereas the findings are different with regard to technological infrastructure as represented by availability of Internet connectivity and speed of communications. Human resource development policies, represented by availability of computer literate workforce, emerged as an important impediment in the adoption of information and communication-led technologies in Nigeria and Uganda.

Six factors, namely: availability of Internet connection, speed of the Internet, availability of skilled workforce, utilities, communications cost and Internet subscription cost, were included in the analysis. Results of multivariate analysis applied to sample firms suggest that all the factors, except the availability of trained workforce, significantly influenced the diffusion of e-business technologies in India. It was not possible to analyse Nigerian and Ugandan data in multivariate framework due to lack of a sufficient number of observations. Nevertheless, bivariate results suggest that country-specific factors have been responsible for varying degrees of adoption of new technologies. Illustrating this, Nigerian firms using telephone and fax found Internet subscription a severe constraint while 30 per cent of firms using similar communications technology in Uganda reported that it was not a constraint. This could be attributed to the lower monthly Internet service provider charges in Uganda (USD 30) as compared to that of Nigeria (USD 44.2) in 2001 (World Bank, 2004).

Results regarding communications cost and the diffusion of e-business technology in Nigeria and Uganda are very different. Many of the sample firms in Nigeria did not find cost of communications a major constraint, while it has been an impediment in Uganda. In Nigeria, firms were so desperate for communications that access rather than cost had become the primary concern for them. However, in 2001, telephone usage charges in Nigeria (USD 0.57) were less than Uganda (USD 0.82) (World Bank, 2004). Firms in both countries have encountered similar problem with regard to the availability of trained workforce for effective use of e-business technologies. A similar 2002 adult literacy rates of the two nations, 66.8 per cent in Nigeria and 68.9 per cent in

Uganda, reflect this (World Bank, 2004), although it should be noted that the adult literacy rate measures the percentage of literate persons of the age 15 and over. However, there are substantial differences in the supply of high-level labour, with Nigeria having considerably large numbers of scientists and engineers despite their being poorly organized for industrial purposes.

There are substantial differences in the opinion of the firms' MDs in Nigeria and Uganda with regard to access and speed of the Internet. Nigerian sample firms reported accessibility as a serious problem, while a reasonable number of Ugandan firms did not find this as a major constraint. A similar pattern is reported regarding speed of Internet, although the low density of Internet, servers in Nigeria and Uganda might be the reason for poor accessibility of the Internet services.

One of the major policy implications of the findings is that developing countries need to focus on institutions that support more efficient physical and technological infrastructure. In turn, efficient physical and technological infrastructure should reduce the cost of communications, which has been identified as a major bottleneck in the diffusion of e-business technologies. Privatization and deregulation of the communications sector might be an option to achieve this objective.

Appendix A Economic wealth and other determinants of the Internet use in SSA (2000)

Country	GDP (USD) at 1995	IU density (per 10,000)	IU index	IH density (per 10,000)	PC density (per 1,000)	Tele density (per 1,000)
Low income						
Ethiopia	115.88	1.58	0.001	0.01	0.945	3.23
Burundi	140.70	7.47	0.009		..	
Sierra Leone	147.39					
Eritrea	155.05	13.05	0.017	0.05	1.608	8.09
Malawi	168.63	14.51	0.019	0.01	1.161	3.86
Tanzania	190.49	32.75	0.044	0.23	2.847	4.87
Niger	202.80	3.73	0.004	0.16	0.466	1.86
Guinea-Bissau	209.76	24.97	0.033	0.17	..	
Chad	217.84	3.92	0.005	0.01	1.341	1.46
Rwanda	241.77	6.47	0.008	0.47	..	
Madagascar	245.80	18.82	0.025	0.34	2.195	3.43
Burkina Faso	252.05	8.38	0.011	0.32	1.257	4.35
Nigeria	253.60	17.57	0.023	0.07	6.587	3.84
Mali	287.74	16.74	0.022	0.08	1.157	3.36
Sudan	319.08	9.65	0.012	0.21	3.216	11.15
Togo	326.61	86.41	0.118	0.34	21.603	9.22
Kenya	328.20	65.21	0.089	0.53	4.891	10.88
Central African Republic	338.57	4.15	0.005	0.02	1.660	2.80
Uganda	347.95	18.01	0.024	0.08	2.701	2.87

High income						
Gambia	370.48	92.11	0.126	0.12	11.514	24.42
Zambia	392.38	19.19	0.026	0.86	6.717	9.20
Ghana	413.25	14.84	0.020	0.01	2.969	9.93
Benin	414.17	24.6	0.033	0.415	1.640	8.05
Comoros	435.79	21.61	0.029	0.58	4.323	10.27
Mauritania	495.68	18.87	0.025	0.45	9.434	7.17
Angola	506.07	22.84	0.031	0.01	1.142	8.39
Guinea	603.40	10.12	0.013	0.25	3.669	8.16
Senegal	609.24	42	0.057	1.93	16.800	20.71
Zimbabwe	620.70	37.08	0.050	2.16	11.867	27.08
Cote d'Ivoire	742.52	27.05	0.036	0.41	6.087	17.01
Djibouti	783.07	21.94	0.029	0.064	10.188	14.09
Congo, Rep.	841.42	1.75	0.002	0.02	3.492	7.68
Equatorial Guinea	1598.60	15.45	0.020	0.13	2.264	
Namibia	2407.60	170.78	0.234	18.51	34.157	68.35
Botswana	3951.10	154.13	0.211	14.53	36.991	89.93
South Africa	3985.10	549.38	0.754	42.95	61.805	133.63
Gabon	4378.00	122.35	0.167	0.28	9.788	32.28
Mauritius	4429.00	728.91	1.000	27.44	100.539	257.85

IUI = internet user index = $\{X_{j,i} - \text{Min}\ (X_{j,i})\}/\ \{\text{Max}\ (X_{j,i}) - \text{Min}\ (X_{j,i})\}$, X_i refers to the Internet user per capita and i and j refer to the number of countries reporting data.

Data Source: The World Bank (2002), 'World Development Indicators', and ITU (2002) 'World Telecommunication Development Report: Reinventing Telecoms'.

7
Collective Action, Competitiveness and E-Business Technologies

7.1 Introduction

This chapter discusses four important factors identified in our study that tend to be closely associated with the adoption of e-business: the potential business activities in which e-business technologies can be adopted, the availability of reliable and affordable ICT infrastructure, the potential gains expected from e-business and the impediments associated with e-business in a developing context. It is difficult to cover all these aspects in one study; we therefore focus on a limited number of objectives in this chapter, which are:

- factors that discriminate advanced users of e-business technologies from others;
- the impact that the perception of management has on the adoption of new technologies;
- impact of the competitive environment on the diffusion of e-business technologies;
- the role of the institutional environment in the growth of e-business; and
- the role of collective actions in the diffusion of e-business technologies.

The remainder of the chapter is organized as follows: The analytical framework and methodology are discussed in Section 7.2. The MDs' perceptions about the benefits and driving forces behind ICTs adoption are presented in Section 7.3. The hypotheses related to the factors that discriminate advanced users of e-business technologies from other firms are discussed in Section 7.4 while Section 7.5 presents and discusses the statistical results. The findings of the study are summarized in Section 7.6.

7.2 Analytical framework and methodology

The programmability, interactivity and networking capabilities of ICTs leads to a number of advantages in the production and export of goods and services, thereby contributing to an improvement in the performance of the firms. The impact of IT on the conduct of firms can be viewed in terms of labour productivity, time saving, reduction in inventory holdings and the reduction in wastage, in ensuring better co-ordination and flexibility in production design, along with improved product quality. ICTs-based production systems require capital and necessitate high-skill labour to exploit their full potential. Hence, ICTs adoption influences, and is simultaneously influenced by, firm performance and conduct. The mutual reinforcement of ICTs and other characteristics of the firms' conduct and performance will thus form a virtuous circle. Figure 7.1 depicts the analytical framework that encompasses the use of new technologies, performance and the conduct variables of the firms.

The adoption of e-business technologies is a function of several factors, including international orientation, competitiveness, efficiency in business processes, optimization of resource used, availability of telecommunications infrastructure, size of firms' operation and so on. Many times, these factors mutually reinforce each other. International orientation, represented by imports, exports, and technological and financial collaboration, and the adoption of e-business mutually reinforce each other. This is because the use of ICTs generally results metaphorically in the death of

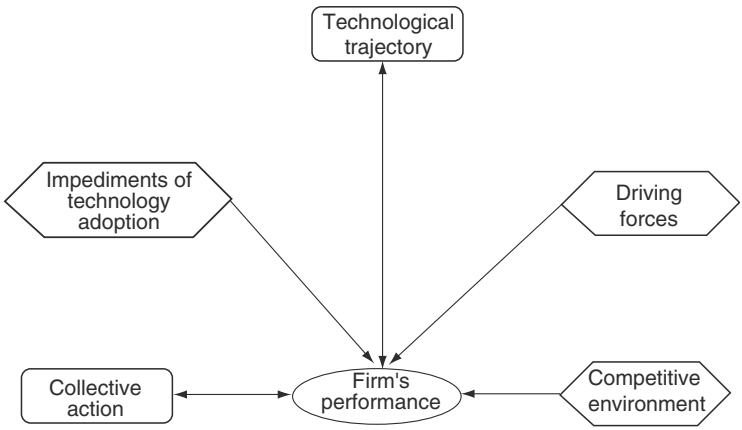

Figure 7.1 Analytical framework

distance (Soete, 1997; Cairncross, 2001). Cairncross (2001) elaborates upon this concept, arguing, 'Barriers and borders will break down' due to the adoption of ICTs. Moreover, e-business is expected to result in fundamental changes in the market landscape. Similarly, sales turnover and the adoption of e-business are expected to influence each other. This holds true not only for the adoption of e-business, but also for any innovative activity carried out on the shop floor.

Although there are several other factors that are prerequisites for the success of e-business, the theoretical framework depicts selected factors that can influence new technologies adoption, specifically the impediments and driving forces behind the adoption of new technologies and collective actions. The role of collective actions becomes fundamental in case the new technologies are not stand-alone technologies and the adoptive firms are SMEs. As the Internet and web-based technologies are not stand-alone technologies, their successful adoption is influenced by factors external to the firms (Oyeyinka and Lal, 2004). SMEs need collective actions such as availability of technological infrastructure and technology-supporting institutions. They also need collective actions with regard to availability of skilled workforce suitable for the effective use of new technologies. The framework also encompasses the increasing role of the prevalent competitive environment in the era of globalization. It is expected that the competitive environment, along with impediments and driving forces, determine the technological trajectory followed by a firm. Moreover, different technological trajectories lead to varying performance of firms. Stated directly, performance and technological trajectories mutually reinforce each other.

Impediments consist of various factors, including the availability of a reliable high-speed communication network, cost of ICTs, trade union pressures and the lack of ICT infrastructure. The existence of a strong reliable communications network is actually a major prerequisite for successful e-business. However, access to a higher bandwidth is not within the control of individual firms. Rather, it forms part of the institutional infrastructure provided by governments. The driving forces include efficiency in production processes, better management control, augmentation in sales turnover and exports due to the adoption of ICTs, opportunity of economies of scope and reduction in production cost. Internal as well as external competitive pressures characterize the competitive environment. In the era of liberalization and globalization, firms in every sector face stiff competition from domestic and multinational firms, although the sources of competitiveness vary from sector to sector and is determined by market preferences. The sources of competitiveness included in the analysis in this chapter are product quality, modularity

of products, innovativeness, size of operation, delivery schedule, market network, technological collaboration with other firms and low overhead costs. Also, higher remuneration is always a major incentive for the workforce to create and adopt innovations effectively and efficiently.

The literature cites numerous benefits that flow from the adoption of e-business (Hodgkinson and McPhee, 2002; Doms et al., 1997). As the Internet enhances relatively inexpensive access to global markets and information, it is fast becoming the world's largest and most versatile marketplace for services, products, and information. E-business has the potential to redefine the existing business infrastructure and to reevaluate the way organizations do business. It has the capability to re-engineer business processes across the boundaries that have traditionally separated suppliers from their customers so that previously separated activities, such as order processing, payments and after-sales services, may be merged into a single process. This results in reducing the costs of creating, moving, processing and managing documents.

Sample firms have been grouped into three categories based on the intensity of e-business technologies adoption. The same procedure of clustering firms adopted in Chapter 4 has been followed. The other variables included in the analysis have been measured on a five-point scale. For instance, MDs were asked to give their opinion about the importance of flexibility in product design, which is quantified as '1' (not important), '2' (to some extent), '3' (important), '4' (very important) and '5' (most important). We did however make an exception in the analysis of the collective action variables. Opportunity learning facilities available in the industrial cluster is measured on a binary scale. The MD's opinion was assigned a value '1' if there existed learning opportunities within the cluster, '0' otherwise.

This chapter uses the forward stepwise multivariate discriminant technique to identify the discriminants of three types of firms: firms using low levels of ICTs, users of moderate ICTs and firms using advanced ICTs. The discriminant technique is used in cases where a random sample of observations, belonging to two or more different groups, is drawn, and where one has to set up a procedure (in terms of measured characteristics, firm-specific variables in this study) to differentiate them as much as possible. The regression models, such as logit and probit, are not suitable as they presuppose causality and require clear-cut identification of dependent and independent variables. For example, in using sales turnover as an independent variable to explain the degree of the adoption of e-business tools, it is assumed in single-equation regression techniques that the use of advanced e-business tools does not contribute to higher sales turnover. The concept of the discriminant analysis, on

the other hand, does not presuppose causality. Its objective is to find a linear function of variables that provides the clearest discrimination between the groups. Discriminant analysis identifies the variables discriminating the two groups without attributing unidirectional causality. Therefore, we consider the discriminant analysis more suitable than regression models (logit and probit) in the present situation. As shown in the theoretical framework, several variables included in the analysis reinforce each other. Hence, the causality is bi-directional. The use of regression models would violate the basic assumption of unidirectional relationship between dependent and independent variables.

7.3 Perception of managing directors

As mentioned previously, the sample firms have been grouped into three categories: firms using low level of ICTs, users of moderate ICT tools and firms using advanced ICTs. Although we have given the same names (low, moderate and advanced ICT-using firms) to the three categories of firms in the three countries, the type of ICT tools used by the same category of firms differs significantly between India and the other two countries. Low level of ICTs in India means office automation tools

Table 7.1 Mean score of the opinion of MDs of Ugandan firms

Variables	**Intensity of e-business technology adoption**			
	Low level	**Moderate**	**Advanced**	**Total**
Driving forces				
MANG_CTRL	2.33	4.91	3.14	3.32
PRO_COST	1.55	4.05	2.57	2.58
HIGH_STO	2.55	4.27	2.86	3.22
INT_COMP	3.74	3.45	3.00	3.55
Sources of competitiveness				
SIZE	1.91	4.04	2.57	2.76
COLL_TECH	1.42	3.52	2.29	2.29
FLEX	2.30	3.78	3.14	2.94
OVER_COST	2.21	3.70	2.71	2.81
WAGES	2.45	3.18	2.57	2.73
R&D	1.52	2.13	2.43	1.84
PROD_QUAL	4.36	4.83	4.00	4.49

Notes : MANG-CTRL, management control, PRO-COST, production cost; HIGH-STO, augmentation of size of operation; INT-COMP, internal competition; SIZE, size of operation; COLL-TECH, technological collaboration; FLEX, flexibility in product design; OVER-COST, overhead costs; WAGES, wages; R&D, innovativeness; PROD-QUAL, product quality.

such as MIS and LAN, while these same tools fall in the moderate category of ICT tools in Uganda and Nigeria. Tables 7.1 through 7.3 present the mean value of the MDs' opinions on the variables included in multivariate analysis. Table 7.1 presents the results related to Ugandan firms.

It can be seen from Table 7.1 that the average of the opinions of MDs of firms using moderate ICT tools on all the variables is higher than firms using low levels of ICT, but less than advanced users of ICTs. This is because while the driving forces and sources of competitiveness are equally very important in all countries, the two African countries have not been able to adopt advanced ICT tools owing to the constraining factors identified in earlier chapters. However, for the MDs of firms using advanced ICTs, these constraining factors have been attenuated and are therefore no longer very important, as they in turn reap the benefits of advanced ICTs. MDs of firms using low levels of ICT have either not achieved the technical level for which these tools are required or are unable to gain access to these facilities. Consequently, Ugandan sample firms did not adopt advanced ICT tools beyond telephone and fax. With respect to internal competition, the opinion of MDs in the first category of firms runs contrary to our proposition. Market orientation is a possible reason explaining this behaviour as firms using low level ICTs might be dealing in the domestic markets, while firms in the 'other' category may be dealing in both internal and external markets as well. Therefore, internal competition is more relevant to the first category of firms.

The average opinion of Nigerian firms' MDs is presented in Table 7.2. We noted that the trend of average opinions in relation to the intensity of ICT tools adopted by Nigerian firms on all the variables is similar to that of Ugandan firms. Few of the firms fall into the category of firms using moderate ICT tools. For this reason, there is less degree of freedom in the computation of the average opinion of this group and the seemingly higher importance of the group should therefore be qualified.

Comparing the average opinion of driving forces behind the varying degree of ICT adoption, we find that the main driving force for firms in the first and second categories is the reduction of production costs. For firms using advanced ICTs, sales turnover has been the most important motivation for ICT adoption. With respect to sales turnover, the opinion is linearly and positively associated with the intensity of ICT tools adopted by firms. Close examination of the average opinion on sources of competitiveness suggests that firms using low level ICTs assigned more importance to factors such as technological collaboration, flexibility in design, overhead costs, wages, innovation activities and product

Table 7.2 Mean score of the opinion of MDs of Nigerian firms

Variables	Intensity of e-business technology adoption			
	Low level	**Moderate**	**Advanced**	**Total**
Driving forces				
MANG_CTRL	3.33		4.33	3.52
PRO_COST	5.00	5.00	4.20	4.61
HIGH_STO	4.04	4.50	5.00	4.32
INT_COMP	3.12	5.00	3.67	3.36
Collective action				
LEARN	0.85		1.00	0.84
Sources of competitiveness				
SIZE	2.09	5.00	3.33	2.61
COLL_TECH	3.57	5.00	3.40	3.67
FLEX	4.73	5.00	4.14	4.64
OVER_COST	3.40	5.00	3.29	3.33
WAGES	3.67	5.00	3.00	3.57
R&D	2.67	3.00	1.80	2.74
PROD_QUAL	4.73	5.00	4.17	4.67
DELIVERY	1.44	5.00	2.00	2.05

Notes : LEARN, learning facilities; DELIVERY, delivery schedule. Expansion of other variables as given in Table 7.1.

Table 7.3 Mean score of the opinion of MDs of Indian firms

Variables	Intensity of e-business technology adoption			
	Low level	**Moderate**	**Advanced**	**Total**
Driving forces				
PROD_EFFI	2.92	3.65	4.13	3.62
MANG_CTRL	3.29	3.59	4.26	3.63
FLEX_DES	2.75	3.52	3.52	3.44
INT_COMP	2.92	3.57	3.65	3.51
EXT_COMP	3.00	3.61	3.74	3.56
Sources of competitiveness				
FLEX	2.46	3.33	3.65	3.27
PROD_QUAL	2.12	3.21	3.52	3.13
DELIVERY	2.71	2.66	3.61	2.76
NETWORK	1.75	2.15	2.83	2.17

Notes : PROD-EFFI, efficiency in production; FLEX-DES, induce flexibility in product design; EXT-COMP, external competition; NETWORK, market network. Expansion of other variables as given in Tables 7.1 and 7.2.

quality as compared to firms using advanced ICTs. A similar explanation as to the one provided for Ugandan firms can be extended to Nigerian firms. With regard to collective action, we only had data on availability of learning and skill upgrading facilities within the cluster.

The opinion expressed by sample firms confirms our hypothesis in relation to its association with the intensity of their ICT tool adoption.

Results of the Indian sample firms are presented in Table 7.3; although, similar to Ugandan sample firms, the data on collective action variables was missing and is therefore not reported in the table. The results presented in Table 7.3 indicate considerable difference in the pattern of opinion expressed by MDs from the two African countries. For Indian sample firms, the average opinions with respect to all the variables are positively and linearly associated the intensity of ICT tools adopted by firms. The MDs of the third category of firms assigned more importance to internal and external competition, compared to their counterparts in firms using low levels of ICTs.

A comparison of opinions on driving forces suggests that efficiency in production processes and better management control are more important than other factors and that external competition ranks higher than internal competition. This could be because of the entry of several multinational corporations (MNCs) since the liberalization of the Indian economy in 1991. That MNCs enjoy many advantages, including better production technology, brand names, and more financial resources, is well known. Consequently, in India large firms, as well as SMEs face stiff competition from foreign firms. There is, however, another dimension to this phenomenon. A large number of the sample firms are in the garments manufacturing sector and many of these firms are completely export-oriented. With a view towards the quota regime ending in 2005, export-oriented firms such as these are concerned with external competition. The results also show that MDs have assigned more importance to modularity and quality of products than delivery schedule and market networking. This is an expected finding because flexibility in product design and product quality is very important in an open economy like India.

7.4 Hypotheses

After presenting the distribution of opinions of the sample firms' MDs, we proceed to formulate hypotheses related to variables included in the analysis. Although the theoretical framework includes driving forces as well as impediments in the adoption of ICTs, we have excluded impediments from the analysis due to lack of data on such factors.

7.4.1 Driving forces

In this subsection, we have formulated hypotheses related to driving forces factors based on the findings of other studies and the abilities of

ICTs to contribute favourably in business processes. Better management control, reduction in production cost, increase in sales turnover, competitiveness and efficiency in production processes represent the driving forces.

7.4.1.1 Management control

Better management technique has been one of the concerns of business organizations irrespective of their nature and size of operation. In the early stages of information processing and retrieval, the systems offered to firms mainly dealt with management information. After the tremendous success of stand-alone systems like MIS, business organizations were offered networked systems like LAN and CIM. Office automation systems offer many advantages including accuracy of information, easier and almost instantaneous access to information, as well as the 'death of distance aspect' of information access. We expected the MDs' opinions to differ significantly among firms that have adopted varying levels of ICTs.

7.4.1.2 Production cost

Until late 1980s and early 1990s, the cost of ICT systems and non-availability of function-specific tools made it difficult to evaluate the real impact of ICT adoption on production cost. The scenario has changed in the last decade with the development of low-cost sector and function-specific systems. Consequently, ICTs have been widely adopted by SMEs and we have been able to assess the impact of specific tools on firms. The major sources for cost savings come from ICT's aid in efficient business management of the attenuation of market uncertainties.

Market uncertainties exist on both the buyer and supplier sides. For instance, a reliable raw material supplier may fail to supply the desired quantity and quality of input due to unavoidable circumstances or rent seekers may supply the raw material at higher costs to the firms that do not have appropriate ICT tools to search for alternative input suppliers. However, firms with access to information are able to find alternative suppliers and are therefore in a better bargaining position. In addition to reducing market uncertainties, the application of ICTs can also contribute to the reduction of production cost by continuously updating costs of inputs, a difficult task for firms that do not have efficient search systems. In view of this role of ICT tools, we hypothesize that the MD's opinion on this aspect will be significantly different among the three groups of sample firms.

7.4.1.3 Augmentation of size of operation

Growth is one of the prime objectives of all firms and several factors, including the search for new markets for existing products and the manufacture of new products for existing markets, can contribute to the growth of firms. Technological profile and entrepreneurship also play an important role in this endeavour. For example, the use of programmable equipment in production processes can change the product mix of firms such as in the electronic sector when the same assembly line produces card less and mobile phones. However, this is only possible when the component inserting system is programmable because a programmable system can change components' insertion coordinates into PCBs. This flexibility is an inherent property of ICTs.

The Schumpeterian and Neo-Schumpeterian literature generally postulates a positive relationship between the firm's size and its technological progress; the size of a firm is indicative of the financial resources to acquire a new technology and enables spending on innovative activities. This is particularly true in the case of SMEs where firms do not have easy access to financial institutions. Till today, SMEs tend to invest their own financial resources to carry out innovative activities. Several studies (Siddharthan, 1992; Lall, 1983) found a positive relationship between innovative activities and size of operation of firms. We also postulate that MDs who consider ICTs as contributing towards higher sales turnover have adopted ICTs that are more advanced.

7.4.1.4 Competitive environment

Internal and external competitiveness represent the competitive environment because in the era of globalization, firms face competition from domestic as well as foreign firms. In the Indian context, there are two reasons for increased competition from domestic and MNCs. First, economic liberalization has allowed the entry of foreign firms into the domestic markets, resulting in increased external competition. Second, until the late 1990s, several products were reserved for SMEs that are largely locally owned; currently, almost all the products have been taken off the reservation list. This allows large Indian firms to manufacture products that previously were not allowed to manufacture, which has resulted in increased domestic competition. One of the options to counter this increased competition was for SMEs to manufacture products of the same quality and features as produced by large domestic firms and MNCs. Movement in this direction is enhanced by ICTs. Hence, we hypothesize that the MDs' opinion on augmentation of competitiveness is likely to emerge as a significant discriminant in the three groups of firms.

7.4.1.5 Efficiency in production

Computer-integrated assembly lines are expected to be more efficient than traditional ones. The efficiency derives from the structure and self-fault detection mechanism built in at crucial stages of manufacturing. For instance, after inserting electronic components such as LSI and VLSI in an electric product's PCB, the input and output parameters of the module are checked at the assembly stage itself. If there is any discrepancy found between the expected and actual parameters, the PCB does not proceed to the next stage of manufacturing processes, but sends the product automatically to the fault correction stage of the production process. In manual or semi-automatic assembly lines, the parameters are checked at the quality control stage of manufacturing, which results in delay in rectifying fault in the product as the product must be disassembled entirely into modules and then the fault is rectified in whichever modules it is reported. Finally, the product has to go through the assembly process again. As we have no prior knowledge of any study investigating the role of ICTs in inducing efficiency in production processes, we expect the MDs' opinions on this aspect to differ significantly among users of varying degree of ICT tools.

7.4.2 Collective action indicators

Collective actions are more relevant for resource-constrained SMEs and ICTs are expected to foster greater efficiency in the adoption of technologies that underpin collective action. This is because SMEs do not have enough financial resources to adopt costly new technology. Although stand-alone ICTs, such as MIS and LAN, are neither costly nor sharable, ICTs such as the Internet and web-enabled technologies do have a costly component associated them, namely a viable communications network. Collective actions are needed to provide learning and skill-upgrading opportunities to their workers within the clusters. Again, SMEs cannot afford to send workers outside the firm's premises for long periods for these activities. Unfortunately, due to lack of data, we have not been able to include all indicators of collective actions.

7.4.2.1 Learning and training opportunities in clusters

For small producers in relatively poor African countries, the cost of staying competitive in skill-based and technology-driven markets is enormous. For this reason, small enterprises require support for skill upgrading. This has two main implications. First, it means that support for autonomous firm-level technical change should be sought from a much wider variety of sources. Within the firm, the sources include the

production lines and the machine shops, among others, rather than focusing exclusively on the R&D laboratory. This finding reinforces the views that have gained ground in recent years on the nature of firm behaviour in systems of innovation. Secondly, external support services crucial to the growth of firms come from public and private sources, including private associations. The knowledge acquired contributes to improving existing old vintage plants, which promises as much economic returns as investment in new vintage plants. Innovation is expected to lead to higher enterprise performance. Given the nature of firms and characteristics of ICTs, we hypothesize that MDs of firms using advanced ICTs give more importance to learning opportunities within clusters.

7.4.3 Sources of competitiveness

The literature on the subject suggests that there exist several sources of competitiveness. Theses sources are dependent upon market preferences and the firm's reputation. Price competition is relevant for a market that demands elasticity with respect to price, whereas quality competition is more important for markets where demand elasticity with respect to price does not exist. The firm's reputation is a major source of competitiveness irrespective of the market preference. We have made an effort to analyse the sources of competitiveness that fall in price and non-price categories. We have also examined the role of competitive factors related to the firm's reputation.

7.4.3.1 Size of operation

The size of operation is a major source of competitiveness (Pratten, 1991). This source of competitiveness relates to reputation of firms, as firms with larger size of operation are in a better position to influence markets. To illustrate this point, a firm with larger size of operation can provide better after-sales support to their customers. After-sales support is more relevant in electronic products. In garment products, larger firms can offer buy-back options in case the shrink ratio exceeds the tolerable limit in a particular garment. For firms with a smaller size of operation, these types of incentives are very difficult to offer. Drawing upon existing empirical materials, we postulate that opinion of MDs on this source of competitiveness will vary significantly across firms using different type of ICTs.

7.4.3.2 Technological collaboration

Several scholars (Stiglitz, 1989; Kiiski and Pohjola, 2002) have emphasized that ICTs play an important role in exchanging information, knowledge

and product designs between manufacturers and suppliers of technology. One of the major contributions of ICTs in the business environment is to facilitate better co-ordination of manufacturing activities. Particularly, online e-business tools may be the best-suited technology to co-ordinate with foreign companies. Moreover, most developing countries have liberalized their economies, making technological collaboration with foreign firms much easier than in the era of inward-looking economies. Technological collaboration helps firms acquire new knowledge of production processes and technologies and new material and so on. Adoption of the Internet and web-based technologies leads to effective technological collaboration. Hence, it is hypothesized that technological collaboration with foreign firms might emerge as an important discriminant of advanced users of e-business technologies and others.

7.4.3.3 Flexibility in product design

Achievement of flexibility in product designs has been considered a major contribution of ICTs (Lal, 1996). For instance, it was virtually impossible to make frequent alterations in garment products because designs were drawn on cardboard. Furthermore, the cardboard designs were cut manually. Adoption of CAD/CAM at the garment's design stage allows the design to be drawn on special paper through a computerized needle. This process allows changes in design as frequently as is needed. Firms that use ICTs, particularly the electronic goods manufacturing sector's FMS, have a competitive advantage in areas such as design and features. Given this property of ICTs, we hypothesize that firms using advanced ICTs have an advantage in flexible manufacturing.

7.4.3.4 Overhead costs

The flexible manufacturing aspect of ICTs can also be attributed to the absorption of a greater part of variations in demand, thereby reducing the need for inventories. This, in turn, will lead to a reduction in the storage costs of raw materials as well as final products. Systems like just-in-time (JIT) are known for reducing the storage cost substantially. Dudley et al. (1989), in their study of North American firms, have supported the above view. Adoption of advanced ICT tools could also result in changes in organizational structure that should result in cost reduction. To illustrate this point, firms using e-mail and the Internet could save a substantial amount of money communicating with their buyers and suppliers, as paper-based communication is time consuming and costlier than electronic communication. Adoption of ICT-based production processes could result in a workforce requiring less

supervision, which again, should reduce overhead costs substantially. Hence, we expect that advanced users of ICTs realize savings on overhead costs.

7.4.3.5 Wages

Although firms using e-business tools do not necessarily require highly paid workers, the average wage paid to an employee by firms using portals is expected to be high. This is because the MDs of firms using portals and their senior technical personnel are normally technically competent individuals who are aware of the tremendous importance of e-business tools in production and organizational innovation. E-business alone cannot improve the performance of firms, but along with factors such as quality of products, after-sales support and innovative capabilities of firms, it can be a catalyst in achieving better performance. In order to manufacture products of flexible design and an improved quality of products, the firm needs highly skilled and experienced workers. Lal's (1996) study suggest that the average wage paid to an employee by advanced users of IT tools was higher than that of non-IT-using firms. We also expect that the MDs of three groups of sample firms corroborate the findings of earlier studies.

7.4.3.6 Innovativeness

Skills and information upgrading support to industry vary in the depth of service. In developing countries, research and development institutions (RDIs), universities and technical institutes, local engineering consultants and foreign partners provide support to domestic industry. Therefore, support can be divided into three broad categories: domestic private, domestic public and foreign. In addition to universities and RDIs, there are institutions providing information and metrological services (standards, testing and quality control). Three forms of institutional support, public, private services and network associations, were identified. The last two fall in the private domain, and differ in their motives and governance structure. Government or public support could be provided indirectly within a macroeconomic package, as technical assistance in training, and as finance subsidy. Government support is, in the main, delivered through technology centres or public RDIs with broad mandates to assist SMEs in carrying out innovation. Private associations are voluntary trade and manufacturing organizations supported through membership dues. Service providers from the private sector operate as consulting organizations and deliver services at a cost. R&D activity is the main source of technological edge in any industry in general, particularly in electronics (Rada, 1982). We expect that firms using

advanced ICTs assign more importance to innovative activities. Their innovative activities could be targeted towards identification of processes for better use of ICT tools.

7.4.3.7 Product quality

Product development, distinctiveness, quality and product differentiation are very important sources of competitiveness. Pratten (1991) analysed the sources of competitiveness of the UK's computer industry and found that the quality of product was the most important factor. ICTs can also make a considerable contribution towards improving product quality and differentiation. The impact of ICTs on product quality can be realized only when these technologies are adopted in production processes as ICT applications like e-mail and the Internet are unlikely to have a significant impact on product quality. The ability of ICTs to simulate the behaviour of electronic products in unusual circumstances such as very high temperature and high humidity levels contribute to product quality. ICT adoption can be the source of additional product improvements. Precision measurement of the error tolerance limit is much higher in ICT-based production processes compared to manual ones. In the garments manufacturing sector, microprocessor-based stitching machines improve product quality by their fine stitching of garments. Hence, we expect that opinion of product quality, as a source of competitiveness, is likely to be significantly different among varying degrees of firms using ICTs.

7.4.3.8 Delivery schedule

This source of competitiveness is very important for the garment sectors' export-oriented units. The delivery schedule of the final products to the consumers can be optimized using JIT delivery system. JIT technology is useful for delivery as well as input suppliers, as inputs to this system include information about the geographical location of the consumption points. Consequently, JIT can be effectively utilized to save time. Other ICT tools, such as e-mail and the Internet, can also contribute in better co-ordination between firm and other business partners. Improving the ability of ICTs to manage uncertainties can also result in improving delivery schedule because buyers in both the domestic and international market can trace consignments at any point of time. This is very useful for a firm's marketing strategy. In his study of SMEs in India, Lal (1996) found delivery schedule an important factor in determining competitiveness of firms. Although we have little information about export intensiveness in Nigerian and Ugandan firms,

we postulate that the opinion on delivery schedule emerges as an important discriminant of three groups of firms.

7.4.3.9 Market network

Recent development in ICTs has focused on networking capabilities; the development of the Internet and web-based communication is a case in point. Consequently, new ICT applications in fields such as business, education and governance have contributed significantly in strengthening local, regional and global networks. Networks can be grouped into two categories, horizontal and vertical. Horizontal networks are characterized by linkages of firms engaged in similar business activities, while vertical networks connect all institutions and organizations in production of one product. These could start with the firms making product designs and end with the product's consumer. Vertical networks are more relevant for the sample firms as they form a part of it. In the era of information revolution, networking has taken a pivotal role in the business applications of ICTs (Castells, 1998). Firms potentially have access to rich information through networking, which in turn can be used as an important input for developing business strategies. In view of the unprecedented networking abilities of ICTs, we hypothesize that MDs of firms using advanced ICTs assign more importance to the networking capability of ICTs.

7.5 Statistical Analysis

The variables discussed in Section 7.4 were analysed using discriminant analysis. It was not possible to analyse pooled data of all three countries because of the varying level of ICTs development in each firm category. Loss of degrees of freedom also prohibited us from using pooled data. For several variables, data is available for firms in one country, but is not available for firms of another country. For instance, data on collective variables were missing from Indian firms, while we had data on this aspect from Nigerian firms. Analysis of Ugandan firms is presented in Tables 7.4 and 7.5, while Tables 7.6 and 7.7 present the results of Nigerian firms. Discriminant analysis results of Indian firms are presented in Tables 7.8 and 7.9.

Table 7.4 presents *F*-statistics along with significance of variables that discriminated firms in Uganda that were using varying levels of ICTs. We could not include collective action variables as sample firms did not report data related to this aspect. The variables that emerged significant determinants are as follows: ability of ICTs to provide better management

Table 7.4 Discriminants of e-business technology adoption in Uganda

Variables	Wilks' Lambda	*F*-Statistics	Significance	Remarks
Driving forces				
MANG_CTRL	0.356	44.298	0.000	Provides better management control
PRO_COST	0.403	36.321	0.000	Reduction in production costs
HIGH_STO	0.494	25.048	0.000	Increase in sales turnover
INT_COMP	0.899	2.740	0.074	Internal competition
Sources of competitiveness				
SIZE	0.451	29.862	0.000	Size of operation
COLL_TECH	0.592	16.859	0.000	Technological collaboration
FLEX	0.645	13.477	0.000	Flexibility in product design
OVER_COST	0.716	9.737	0.000	Overhead costs
WAGES	0.872	3.591	0.035	Wages
R&D	0.880	3.349	0.043	Innovation activities
PROD_QUAL	0.904	2.612	0.084	Product quality

Table 7.5 Classification results of Ugandan firms

Original group membership	Predicted group membership			Total
	Low	Moderate	Advanced	
Low level of e-business technology using firms	24 (92.3)		2 (7.7)	26
Moderate users		20 (100.0)		20
Advanced e-business technology using firms	1 (16.7)	1 (16.7)	4 (66.7)	6
Ungrouped firms	2	1	1	4
Total discriminating power of the model is 92.3 %				

Note: Figures show the number of firms classified in each group, while row percentage is presented in parentheses.

control, the adoption of ICTs results in production cost reduction and increase in sales turnover, and internal competitive pressure. Among the sources of competitiveness, size of operation, technological collaboration, flexibility in product design, ability of ICTs results in reducing overhead

Table 7.6 Discriminants of e-business technology adoption in Nigeria

Variables	Wilks' Lambda	*F*-Statistics	Signifi cance	Remarks
Driving forces				
PRO_COST	0.836	1.957	0.167	Reduction in production costs
Collective action				
LEARN	0.676	4.783	0.020	Learning facilities within cluster
Sources of competitiveness				
DELIVERY	0.318	11.786	0.002	Delivery schedule
SIZE	0.583	3.929	0.052	Size of operation

Table 7.7 Classification results of Nigerian firms

Original group membership	Predicted group membership			Total
	Low	Moderate	Advanced	
Low level of e-business technology using firms	7 (87.5)		1 (12.5)	8
Moderate users		2 (100.0)		2
Advanced e-business technology using firms	2 (50.0)	1 (25.0)	1 (25.0)	4
Ungrouped firms	5	2		7
Total discriminating power of the model is 71.4 %				

Note: Figures show the number of firms classified in each group, while row percentage presented in parentheses.

costs, low wages, innovativeness of firms and product quality discriminated the three types of firms.

The emergence of MANG_CTRL as the most important discriminant substantiates the findings of earlier studies (Lal, 1996; Mehta, 2000). Although Ugandan firms were not using LAN technologies, the use of office automation technologies might have provided better control of information to MDs. Hence, MDs of firms using advanced ICTs might have given more importance to better control of information. Although the importance (2.58 on a scale of 5) given to PRO_COST is lower than all the driving forces variables, opinion significantly varied between low (1.55) and moderate (4.05) users of ICTs, which could have led to high

Table 7.8 Discriminants of e-business technology adoption in India

Variables	Wilks' Lambda	*F*-Statistics	Significance	Remarks
Driving forces				
PROD_EFFI	0.930	8.531	0.000	Efficiency in production
MANG_CTRL	0.941	7.152	0.001	Provides better management control
FLEX_DES	0.959	4.833	0.009	Induces flexibility in product design
INT_COMP	0.961	4.609	0.011	Internal Competition
EXT_COMP	0.967	3.859	0.022	External Competition
Sources of competitiveness				
FLEX	0.943	6.914	0.001	Flexibility in product design
PROD_QUAL	0.946	6.569	0.002	Product quality
DELIVERY	0.968	3.714	0.026	Delivery schedule
NETWORK	0.969	3.680	0.027	Market network

Table 7.9 Classification results of Indian firms

Original group membership	Predicted group membership			Total
	Low	Moderate	Advanced	
Low level of e-business technology using firms	22 (91.7)	2 (8.3)		24
Moderate users	35 (19.0)	101 (54.9)	48 (26.1)	184
Advanced e-business technology using firms	1 (4.3)	4 (17.4)	18 (78.3)	23
Total discriminating power of the model is 61.0 %				

Note: Figures show the number of firms classified in each group, while row percentage is presented in parentheses.

discrimination power of this variable. Firms using moderate levels of ICTs gave high importance (4.27) to HIGH_STO, while MDs of firms using e-mail and the Internet-using firms did not, giving it 2.86 on a five point scale. Apparently, all the firms gave high importance to internal competitive pressures for being the main reason for adopting ICT. Consequently, the discrimination power of this variable is lowest (10 per cent significant) among other driving forces variables.

Although average opinion of MDs on size of operation as a source of competitiveness was 1.91, it emerged as the most important source of competitiveness, possibly because firms with smaller size of operation may be engaged in contract manufacturing of intermediate product. Consequently, size of operation was not important for them, as they were not directly dealing with their products end users. Similarly, firms using low levels of ICTs did not consider technological collaboration as important source of competitiveness. This may be due to the same reason as in the case of size of operation. Although flexibility of product design did not emerge as most important discriminant, the average opinion (2.94) of MDs is highest among other sources of competitiveness. Low discriminating power of FLEX could be attributed to the fact that MDs of all the three groups assigned similar and high importance to this source of competitiveness.

MDs of firms using moderate ICT found that the adoption of ICTs in production processes leads to reduction in production costs. Although this variable emerged as a significant determinant in the three groups of firms, MDs of other firms did not agree with firms using moderate levels of ICT. Similar opinions were expressed with respect to low wages as a source of competitiveness. Table 7.4 shows that the opinion on innovativeness, represented by R&D, differs significantly between firms using low levels of ICTs and others. Although this variable has emerged significant in discriminating the three types of firms, MDs in general did not consider this an important factor for their business as reflected in their average opinion of 1.84. This is not surprising because in-house innovative activities are not very relevant for SMEs. As expected, product quality has been considered the most important source of competitiveness. The opinion is relatively uniform across all type of firms and, therefore, is not very significant (10 per cent only) in discriminating the three types of firms. The findings suggest that quality competition is also prevalent in the developing countries.

Table 7.5 presents statistics related to the discriminating power of the discriminant function. The table shows that 92.3 per cent of firms using low levels of ICTs can be correctly classified by the linear combination of the variables discussed above. The discriminant function is competent to classify the second category of firms 100 per cent correctly. The total discriminatory power of the function is considered very high at 92.4 per cent.

As we did not have data from Nigeria, we could not include all the variables in one discriminant function. Although many other variables might be significant discriminant of three types of firms, we present and discuss the discriminant function that has the highest discriminating

power. As seen from Table 7.6, the reduction in production cost has emerged as the most important factor among the driving forces. This suggests that price competition is more important than other factors.

The data on collective action variables were available for Nigerian firms. We included them in the analysis and found that learning facilities within the cluster (LEARN) emerged as a significant discriminant of different levels of ICT using firms. Table 7.6 shows that availability of learning and upgrading facilities within industrial cluster was considered the most important factor in adopting new technologies. Among the sources of competitiveness, delivery schedule and size of operation were important discriminants in the three groups of firms. These results agree with the findings of earlier studies (Pratten, 1991; Lal, 1996). Although we do not have enough data on the export intensity of firms, the emergence of delivery schedule as an important discriminant suggests that firms were doing business in internal markets. Neither delivery schedule nor ICT tools used are very important for firms that deal locally as they cannot contribute significantly in their endeavour.

Table 7.7 presents classification results of the discriminant function used for Nigerian sample firms. Table 7.7 shows that 87.5 per cent of firms using low levels of ICTs can be classified correctly by the discriminant function. As with the discriminant function used in Uganda, the discriminant function used for Nigerian firms is competent to classify 100 per cent of firms using moderate levels of ICTs. The classification power of function in identifying firms using advanced ICTs is very low (25 per cent). The total discriminating power of the function is 71.4 per cent, which is considered within reasonable limits of accepting a discriminant function.

The results for Indian sample firms are presented in Table 7.8. The results are similar to those of Ugandan firms. Among the driving forces that have emerged significant are efficiency in production processes, ability of ICTs in providing better management control, the contribution of ICTs in manufacturing products of flexible designs, and internal and external competitiveness. The survey found that several firms adopted ICTs in production processes. The adoption of programmable equipment in production can result in higher efficiency, which may be the reason for attributing more importance to this aspect of driving forces. Importance of better management control and ability of ICTs in inducing flexibility in product design is according to our expectation and is in accordance with the existing literature (Lal, 1996; Doms et al., 1997). The importance assigned to internal and external competitive pressures by firms using advanced ICTs suggest that they compete in the domestic and international markets. As mentioned earlier, Indian SMEs are subjected to these

pressures due to entry of MNCs into the domestic market and the de-reservation of products previously reserved for SMEs.

The sources of competitiveness, represented by flexibility in product design, product quality, delivery schedule and market networking have emerged significant discriminants of varying degree in firms using ICTs. The results support the findings of earlier studies (Lal, 1996; Pratten, 1991). As discussed earlier, roughly one third of Indian sample firms belong to the garments manufacturing sector and a large number of these firms are export-oriented. Delivery schedule is very crucial for them and the ICTs adopted by them might augment their competitiveness. This could be the reason they assigned higher importance to delivery schedule. However, delivery schedule is unlikely to be an important factor for firms manufacturing electronic goods for the local market. The emergence of market networking is a unique finding. Theoretically, networking technologies such as the Internet and web-based networks have the potential to strengthen the marketing network of firms. Owing to stiff competition in the domestic and export markets, this source of competitiveness has been assigned more importance. Market network, however, has been considered a major source of competitiveness by firms using low-level ICTs. Apparently, these firms are sub-contractors of large firms, and market networking in not very relevant to them. This difference of opinion among firms using varying levels of ICT has resulted in the emergence of market networking as a significant discriminant.

Table 7.9 presents the classification results of the Indian sample firms. As seen in the table, the classification power of firms using low-level ICTs is very high at 91.7 per cent. Unlike the Ugandan and Nigerian firms, only 54.9 per cent of firms using moderate levels of ICTs can be classified correctly. The competence of discriminant function in classifying firms using advanced ICTs is high (78.3 per cent). Although total discriminating power of the function (61.0 per cent) is not very high, it is still within the acceptable limit of 50 per cent. The low discriminating power could be attributed to the sample firms' uniformity of opinion regarding factors such as better management control, external competitive pressures and flexibility in product designs.

7.6 Summary

In this section, we identify and analyse the factors that discriminate three groups of firms: low level of ICT users, firms using moderate ICTs, and users of advanced ICT tools. Firm-specific factors included in the analysis fall into three broad categories: driving forces, collective actions

and sources of competitiveness. It was not possible to analyse pooled data for all the firms located in three different developing countries mainly because of the substantial differences in the types of ICT tools used by the same category of firms in different countries. For instance, firms using MIS and office automation technologies were classified as moderate users of ICTs in Uganda and Nigeria, while firms using same technologies in India were classified as low level of ICT users. The second reason for not analysing pooled data was the loss of degrees of freedom, as we found that data for several variables was available in one country but was missing in another. The variables in the analysis include management information control benefit, reduction in production costs, abilities of ICTs in increasing sales turnover, potential to strengthen competitiveness of firms, efficiency in production process due to adoption of ICTs, learning opportunities within industrial clusters, size of operation, technological collaboration, innovativeness, low overhead costs and wages, flexibility in product design and product quality. Except for learning opportunities within clusters, which was measured on a binary scale, all the variables were measured on a five-point scale.

Cluster analysis was used to classify firms into each category, that is, low level of ICT users, firms using moderate ICTs, and advanced users of ICTs. Separate cluster analysis was carried out for firms located in each country. This was necessary because the type of ICT tools adopted by firms in the three countries were significantly different. For instance, almost every sample firm in India was using MIS and automations tools, while a substantial number of firms in Nigeria and Uganda used only telephone and fax and did not have computers in their premises. The forward stepwise discriminant analysis technique was used to identify factors that discriminate the three groups of firms from each other. The factors that emerged as significant determinants in the three types of firms are different in the three countries.

The results of Ugandan sample firms suggest that the generic property of ICTs in providing better management control was the most important factor that discriminated the three types of firms. The other variables that discriminated different levels of ICT-using firms were contribution of ICTs in reducing production costs, augmentation of sales turnover due to adoption of ICTs and internal competitive pressures. Among the sources of competitiveness that emerged as significant discriminants were size of operation, technological collaboration and contribution of ICTs in manufacturing modular and high quality products, innovativeness and ability of ICTs in reducing overhead costs. Wages have also emerged as an important discriminant in Ugandan sample firms. The

significant discriminants in Nigerian firms were reduction in production costs, availability of learning and upgrading opportunities within industrial cluster, size of operation and delivery schedule. We could not include other factors in the Nigerian firms due to substantial loss of degree of freedom. The factors that emerged as significant discriminants of varying degrees in firms using ICTs in India were similar to that of Uganda. An additional factor, that is, contribution of ICTs in inducing efficiency in production processes, has emerged as the most important discriminant in the three types of firms. Among the sources of competitiveness, the ability of ICTs in strengthening the market network also discriminated firms using advanced ICTs from the others. In several respects, the findings of this study are similar to that of other studies (Doms et al., 1997; Bedi, 1999; Siddharthan, 1992; Cohen, 1995; Pavitt et al., 1987; Soete, 1997; Cairncross, 2001).

The findings of the study suggest that MDs who considered flexibility in product designs and product quality as important sources of competitiveness adopted more advanced ICT tools. Technological collaboration emerged as an important discriminant in Ugandan firms, while the opinions of Indian sample firms' MDs did not differ significantly. This may be due to the technological collaboration with foreign firms found in almost every Indian sample firm since the liberalization of Indian industrial policies in 1991. Since then, Indian firms do not require any licence for collaboration, whereas this may not be the case in Uganda. Technological collaboration by SMEs with foreign firms in Uganda may not be economically viable for very small firms, while firms with reasonable size of operation could have appropriated the benefits of collaboration and hence, it was a source of competitiveness. Market network emerged as a significant discriminant in Indian sample firms and not in the other two countries. A possible explanation for this is the availability of a reliable communications network in India as compared to other two countries. Therefore, MDs of sample firms in Uganda and Nigeria did not consider that ICTs can contribute in market networking. Apparently, the opinion was uniform across the three types of firms. Emergence of low wages and low overhead costs as important discriminants in Ugandan firms suggest that, apart from quality competition, price competition was also prevalent in the country.

In addition, the chapter suggest that a number of policy measures need to be taken by governments in developing countries to improve the competitiveness of Micro SMEs (MSMEs) and SMEs. First, state policies should encourage greater private sector participation in setting up training and information service centres within industrial clusters.

These institutions could provide need-based skills for better usage of new technologies. Second, we recommend that MDs of MSMEs are encouraged in the process of upgrading their workforce's skills levels. This could be done by organizing orientation programs to raise awareness of MDs related to new technologies. Also, there is need to subsidize the cost of new technology equipment so that new technologies become economically viable for small firms. New technologies can be made more widely available to small firms by the setting up of technology service-providing organizations. This is more relevant for ICTs such as e-mail and Internet. Setting up technological support institutions may be useful in SME clusters. These institutions could be useful in searching function- and job-specific ICT tools that are expected to be efficient and cost effective. Such collective cluster initiatives should result in better cluster performance.

The study also shows that due to the lack of a reliable and affordable communications network, firms in Uganda and Nigeria did not assign much importance to ICTs' networking capabilities. A study by Mehta (2000) suggests that the availability of higher bandwidth is a prerequisite for the penetration of the Internet and web-enabled services. This study concludes that a very reliable and affordable telecommunications network is required to harness the potentials of ICTs. The technology convergence measures that enable the communication of audio/video/data signals on the same medium are likely to boost the diffusion of Internet. This should result in faster growth of e-business. The findings in this chapter suggest a need to create proper local, national and global information infrastructure to derive the maximum benefit from the ICT revolution. Privatization and deregulation of the communications sector can improve local and national infrastructure, while allowing private and public sector organizations to own international gateways that can significantly improve the global information infrastructure.

8
Growth of Employment and the Adoption of E-Business

8.1 Introduction

The findings of the firm-level studies reviewed in Chapter 1 largely relate to developed economies. As there was no prior study carried out in a labour surplus economy such as India, the study examines direct and indirect impact on employment due to production, and the adoption of ICTs in India. The case of India is relevant because the country has made its presence felt in global software production on the one hand, and is facing serious unemployment problems on the other. A long series of data is needed to examine the impact of ICT adoption on employment; however, it is extremely difficult to collect data on workforce[16] for a long period of time. Hence, we have used the case study method to address the issue of employment and new technologies adoption, which we have subsequently referred to as e-business technologies in business organizations. Since the effect on employment is expected to be more visible in large firms, we have selected top few firms of skill- and labour-intensive sectors. While investigating the effect on employment, we have also taken into consideration the employment generated by the development of e-business technologies. In this study, we present case studies of the top eight firms in three industrial sectors: e-business technologies–producing (that is, ICT sector), consumer electronics and the garments manufacturing industry. The selection of firms is based on sales turnover in the last five years.

The remainder of the chapter is organized as follows: Section 8.2 discusses the sample firms along with their background and type of technologies adopted. In Section 8.3, we analyse the impact of the adoption and production of e-business technologies on direct and indirect

employment created by them and the findings are summarized in Section 8.4.

8.2 Background of sample firms and their technological profiles.

The sample includes firms that produced e-business technology, as well as those that used such technology. Within the technology using firms, we cover two extremes of the industrial spectrum. First, we study the modern industry segment represented by consumer electronic and components manufacturing firms and second, we examine the traditional industry represented by garments manufacturing firms, considered a labour-intensive industry. Sample firms have been selected based on their location as well as financial performance in the last five years. Although national and global institutional infrastructure is not a state subject, various states might have played a catalytic role in providing the local infrastructure and proper environment that is conducive for the diffusion of e-business technologies. Hence, we consider the coverage of sample firms located in various parts of the country, which is very important for this study.

The identification of technology-producing firms and consumer electronic and components manufacturing firms was not difficult, as they are well known in the Indian market. Sales turnover and firm address were taken from the Capitaline database[17] while employment data were collected through personal interviews with senior representatives of the firms. The size of operation and other details of garments manufacturing firms were taken from Apparel Export Promotion Council (AEPC), a government agency attached to the Ministry of Commerce, GOI. Table 8.1 presents the size and growth of sample firms during 1994–95, whereas Appendix A presents their product and technological profiles.

8.2.1 Case studies

The subsection presents case studies of the top three firms producing e-business technology, the top two consumer electronic firms from the science-based sector and the causes and consequences of the adoption of e-business by three largest garments manufacturing firms.

8.2.1.1 Technology producers

We present the case studies of Wipro, Infosys and Satyam. These firms are engaged in different subsectors of ICT industry. Infosys represents the software subsector and Satyam represents the Internet-service-providing

Table 8.1 Size and growth of firms

Firms	Sales turnover: 2003–04 (million rupees)	Employment: 2003–04 (Persons)	Annual growth of sales turnover since 1994–95	Annual Employment growth since 1994–95	Average annual expenditure on e-business technologies (million rupees) in 2002–03
Technology producers					
Wipro	52,080.0	30,000	59.21	43.68	NA
Infosys technologies	47,608.9	25,634	70.46	47.72	NA
Satyam infoway	2,801.1	2,776	47.34*	42.65*	NA
Technology users					
Consumer electronics@					
Videocon	47,464.7	24,693	20.96	9.69	180
BPL	24,764.5	11,413	20.63	9.61	200
Garments					
Orient crafts	7,078.4	15,030	30.05	16.67	4.7
Gokaldas images	2,801.1	6,037	19.56	10.49	4.5
Sonal garments	2,651.5	5,104	15.61	10.01	1.2

* since 1999–2000
@ Financial data belongs to 2002–03.
Note : NA, not applicable.

industry. Although Tata Consultancy Services is also one of the top ranking companies in India, we selected Wipro, which has a presence in ICT hardware as well as software.

8.2.1.1.1 Wipro. The Wipro group is a conglomeration of five companies: Wipro Infotech, Wipro Technologies, Wipro Corporate, Wipro Learning and Wipro consumer care and lighting. For the purpose of this study, we will discuss Wipro Infotech and Wipro Technologies (Wipro hereafter). Wipro Infotech was set up in 1983 with an objective to serve the domestic ICT market including hardware, software and services. Wipro Technologies was set up to cater to ICTs-related services in the international markets. At present, Wipro operates from more than 200 locations. The performance of Wipro has been particularly impressive since the liberalization of the Indian economy during 1991–92. As shown in Table 8.1, the compound annual growth rate (CAGR) of Wipro's sales turnover has been 59.21 per cent since 1994–95.

Wipro is not lagging behind in the development of e-business technologies and has recently developed DOCUSMART, an e-business solution software designed to integrate all documentation-related functions in the total business activities of a firm. It has been implemented in a few companies of the traditional sector such as the tobacco and automobile industries. Recognizing the need for an integrated business solution rather than process- and function-specific tools, the company has very recently developed a system integrated service package as an integrated e-business solution to firms. As has been experienced by Systems and Application Products (SAP),[18] the e-business solutions need considerable customization at the firm level. Wipro has not only started providing integrated software solutions, but also started providing communications infrastructure, one of the prerequisites for the success of e-business technologies.

Although the company has not created any significant indirect employment opportunities, due to development of e-business solutions and other software products during 1994–95, direct employment has experienced an annual growth of 44 per cent. The company is in the process of developing business solutions for SSIs which, if successful, could lead to huge indirect employment. The company intends to create a dealership network to interact with end-user organizations. It has a very powerful network of dealers to provide ICT hardware solutions, which in the opinion of management will, however, not be competent in providing e-business solutions to firms. The company expects that economic growth in general will significantly influence the diffusion of

e-business technologies that have a large potential of employment. It does not visualize any adverse impact of the adoption of e-business technologies on the employment opportunity and profitability of SSIs.

8.2.1.1.2 Infosys. A group of engineering graduates from the Indian Institute of Technologies established the company in 1981. The company is in the business of software products and services, particularly in international markets. They feel that a major hindrance in the diffusion of e-business technologies in Indian SSIs is the absence of affordable and reliable communications infrastructure.[19] The company is hesitant in developing e-business solutions for SSIs due to a lack of scalability of the product and the inability of SSIs to exploit the full potential of such advanced technologies. However, the firm has recently developed an e-business software solution known as FINACLE for the banking sector that is being successfully used by a few Indian banks. Other well-known industrial software solutions developed by Infosys are Supply Chain Management (SCM), Warehouse Management System (WMS), and Transportation Management System (TMS).

As 98.5 per cent of the company's business is in export markets, it has very little experience with regard to the impact of e-business technologies on low-income users. However, the company's direct employment has grown at 47.72 per cent since 1994–95 due to the development of software solutions. A wide range of industrial sectors that includes electronic goods manufacturing, chemical industries, automobile and intermediate goods manufacturing firms use the company's e-business solutions. Unlike Wipro, the company has no immediate plans to develop e-business software solutions for the Indian SSIs, although they might enter into software development for large corporations with available financial resources for their own business infrastructure. The management of the company feels that adoption of e-business technologies will not have any significant adverse impact on employment in Indian SSIs, but they cannot use such technologies effectively owing to infrastructure related problems. Hence, the diffusion of such business solutions will be constrained unless an affordable and reliable communications infrastructure is in place.

8.2.1.1.3 Satyam Infoway. Satyam Infoway is a sister company of Satyam Computers. Although the parent company has been in existence for some time, Satyam Infoway was not established until 1996. This firm, rather than relying on the existing technologies, chose to adopt Internet and Internet-related technologies that were then very

new to the Indian market.[20] Since its launch, Satyam Infoway has focused on Internet-related software services. The company has also entered into the area of e-business solutions and is trying to establish itself as a leader in this field. It can be seen from Table 8.1 that the firm has experienced comparable growth in employment and sales turnover to other ICT firms in India.

Apart from generating direct employment, Satyam has created huge indirect employment opportunities. At present, the company has a very powerful network of more than 1500 cyber cafes in the country. Depending on the city and state, each cyber cafe employs three to five persons on average. In addition, there is a huge network of dealers employing more than 7000 persons. The dealers assist consumers in making Internet connections through Satyam's server, as well as providing technical assistance to end users. Thus, these agencies act as single-window solution providers for all the services offered by Satyam.

The firm is planning a major enhancement of its e-business solutions portfolio. Realizing that e-business solutions will not succeed without a proper communications network, it has set up a private communications network covering 16 major Indian industrial cities. Ensuring the authenticity of electronically transferred documents is another impediment in the diffusion of e-business technologies. Despite the fact that the GOI has legitimatized electronically transferred documents, most companies do not accept the documents unless signed by an authorized person. In this context, Satyam is presently the only firm with a licence from the GOI to certify and provide the electronic signature of any individual. The electronic signature can be sent along with the document or separately. The management of Satyam is of the opinion that e-business technologies are poised to create huge employment opportunities and will enable firms to conduct business in a more organized manner.

8.2.1.2 Technology-using firms

In this section, we examine evidence of the impact of e-business technologies on large firms that have adopted such technologies. The first two firms examined belong to the capital- and skill-intensive sector, while the last three firms represent the labour-intensive sector.

8.2.1.2.1 Videocon. Videocon International came into existence in 1981. The company manufactures both home appliances and entertainment electronics. For the purpose of this study, we use data related to entertainment electronics exclusively. With a network of 18 manufacturing plants, 52 corporate offices and more than 7050 dealers

throughout the country, Videocon is the largest consumer electronics company in India. The company started using SAP e-business solutions in 1991. In the early years, the adoption of such sophisticated business solutions was not very successful due to absence of a desirable communications infrastructure. Since 1997, the firm has been using satellite-based communications technology; all its manufacturing plants, corporate offices, foreign offices and plazas are connected online. In recent years, the company has augmented the SAP-supplied e-business solutions.

The firm has established technological collaborations with foreign firms located in Japan (Nakamashi, Sansui) and the USA (Telecruz Inc.). The company has its own Internet server that functions as a hub to their Intranet. The management of the company feels that e-business technologies have drastically reduced the technological gap in manufacturing between the company and its counterparts in the developed world. They have successfully exploited the B2B segment of e-business technologies. However, there has been very little success on B2C front. Videocon attributes this to the lack of awareness about the Internet in Indian society. They also feel that the communications technology available for the general public is not powerful enough to download the hypertext related to various products.

Videcon has several advantages in the adoption of e-business technology and has been able to save about 30 per cent on transaction costs in their business functions. As shown in Table 8.1, employment in the firm has registered an annual growth of 9.69 per cent since 1994–95. When MNCs entered the Indian market in 1991, several established consumer electronics firms (Texla Televisions, UPTRON) could not survive even in the domestic market. However, Videocon not only survived, but it also maintained its market share, and sales turnover has grown at 20.96 per cent since 1994–95. The company attributes the generation of indirect employment of about 5000 persons by the plazas to the adoption of e-business technologies. As mentioned earlier, the company has a network of 1000 plazas and each plaza employs on an average five persons. It has not encountered any adverse impact of the adoption of these technologies.

8.2.1.2.2 BPL. British Physical Laboratory (BPL) has been in existence for several decades. Having started as a consumer electronics firm in 1963, it has since diversified into entertainment electronics, home appliances, electronic components, soft energy, health care and power generation. However, the data presented in Table 8.1, Appendix A and

discussion in this subsection pertain to the company's entertainment electronics section and is referred to as BPL hereafter. The firm was an early adopter of ICTs in India, taking advantage of the notable shift in the use of ICTs in 1998–99. The benefit has been significant; in addition to a network of more than 1500 dealers, BPL now has more than 50 corporate offices and service centres in the country. All their offices, manufacturing plants and important dealers are connected through satellite (VSAT).

The firm uses several modules of e-business technologies, such as the COREMAN software used for process control in manufacturing, planning, procurement and inventory management. This ICT-related organizational change has resulted in several benefits of the adoption of e-business technologies. First, the interaction between consumer and the company through service centres has been possible due to the adoption of Intranet technologies. This interaction has enabled the company to address their problems more effectively, and has resulted in product quality improvements. The management of the company opined that while they have not been able to increase their market share, they have certainly been able to maintain it.

As far as the impact on employment and profitability is concerned, direct employment has grown at 9.61 per cent, while sales turnover has also increased significantly. The adoption of e-business technologies has contributed to the indirect employment of about 1500 persons. Adoption of portal-based technologies, along with the product quality and better services, have resulted in an annual growth of 20.63 per cent in sales turnover since 1994–95. The company has not experienced any retrenchment of skilled and unskilled workforce as a result of the new business model. The company regards B2B e-business technologies as very productive, while B2C has not been successful. The reason for the relative lack of success relates to the socio-cultural 'touch and feel' ways of doing business in the Indian society. With regard to financial transactions, only 30 per cent are attributed to e-transactions.

8.2.1.2.3 Orient Craft. Established in 1978, Orient Craft is the largest garments exporting firm in India. They have maintained their position for the last several years. At present, the firm has eight branches located in and around Delhi. An Intranet using an ISDN line connects all the company's branches. Although this is a 100 per cent export-oriented unit, it uses indigenously developed e-business technologies. There are two main components of e-business used by the firm: to interact with the foreign buyers and to interact with other business partners in India.

Remote login technologies are used to download designs from the uniform resource locators (URLs) of foreign buyers, whereas Internet and Intranet technologies are used to co-ordinate activities with other company branches and suppliers of raw material. The firm has used CAD/CAM in the design and pattern-making stages of garments manufacturing since 1992.

Table 8.1 shows that the firm has performed extremely well in the international markets and registered a CAGR of sales turnover at 30.05 per cent. Contrary to the general belief that the adoption of ICTs results in a reduction of jobs for unskilled workers, this has not been jobless growth. An impressive growth of employment, that is, 16.67 per cent in the firm, suggests that this perception about ICTs may not be true. The management believes that the use of the enterprise resource planning (ERP) module of e-business in personal management, accounts and documentation has significantly improved the performance of the firm. The application of SCM techniques has not only induced efficiency in business transactions with suppliers, but has also created indirect employment of a few ICT professionals in supplier firms. Despite being a labour-intensive sector firm, they did not face any resistance from workers while implementing ICTs. Thus, the growth of employment, while adopting e-business technologies, may be taken as an indication of no job loss due to the adoption of such technologies. In fact, the management attributes the impressive performance of the firm to the adoption of the latest business models.

8.2.1.2.4 Gokaldas Images. With 18 manufacturing plants in Bangalore, Gokaldas Images has been one of top three garments manufacturing firms in India. The performance of the firm has been continuously improving since its inception in 1972. The company has adopted the latest garments manufacturing technology as and when it is available. It has been using CAD/CAM since 1995. In 1997, the company set up LAN of 150 nodes in their corporate office, and in the same year, it extended e-mail facility on all nodes of the LAN. An Intranet using an ISDN line connects all their manufacturing plants. In 1999, the firm imported a general sewing data (GSD) system from the UK and installed and integrated GSDs in the firm's Intranet. The firm finds the integration of GSDs with the Intranet very useful in the planning and monitoring of manufacturing activities of various plants.

The firm has recently begun implementation of indigenously developed ERP software, STAGE, which was created exclusively for export-oriented garments manufacturing units. Although the firm has not fully

implemented STAGE, the management believes that its e-procurement and electronic data interchange (EDI) modules will have a significant impact as the firm uses the Internet to interact with foreign buyers and other business partners. Despite severe competition in international markets, especially from China, the firm has been able to improve its performance. Table 8.1 shows that along with increasing sales turnover, employment opportunities have also increased. The management is of the opinion that it may not be possible to survive in international markets without the use of new technologies such as e-business, and it did not encounter any adverse impact in its adoption of new ICTs. However, there is no evidence to show that proximity of technology providers has any impact on its adoption by the firm. I may mention here that Bangalore is referred to as the electronics capital of India and is known for providing software solutions to a large number of firms located in the US, the UK and other developed countries.

8.2.1.2.5 Sonal Garments. This multi-plant firm started in 1976 and currently has manufacturing plants in Salem, Tiruppur, Bangalore and Delhi, while their corporate office is in Mumbai. Although their corporate office is fully computerized with a LAN in place, the firm has not linked its manufacturing plants through their own Intranet. Instead, they co-ordinate the business activities of manufacturing units with their own web site and through the Internet. The firm uses remote login technology to interact with foreign buyers. The e-business technology profile of the firm consists of LAN, Internet, CAD/CAM and the company's web site. The management of the firm admits that pressure from the buyers has been the driving force behind the adoption of new technologies. The firm uses the Internet very effectively for searching out new buyers and participates in the Internet bidding of contracts.

The impact on e-business technologies is visible in the firm's performance. The management claims that in addition to contributions in product design and augmentation of productivity of workers, the adoption of remote login technologies has reduced the transaction cost by around 30–40 per cent. The company has not been able to link all the manufacturing units as they are located in various parts of the country. It requires a huge investment in private telecommunications network that may not be economically viable. Like all other sample garment firms, Sonal has also not experienced any negative impact of the adoption of e-business technologies.

8.3 Adoption of e-business technologies and their consequences

Every technological development has a gestation period. Being very pervasive technologies, ICTs have been the fastest growing technologies in the last decade; adopters expected a dramatic impact on their performance. Like the productivity paradox of general ICTs before the early 1990s, the impact of e-business technologies has also been ambiguous (Hecker, 2001; Pohjola, 2001). However, this paper did not find any evidence to support the argument that adoption of e-business technologies results in loss of workplaces, and discusses the influence of ICTs on producers as well as consumers separately.

8.3.1 Producers

The Indian ICT industry in general has experienced an average growth of 55 per cent in the last decade. Indian producers of these new technologies have been mainly concentrating on international markets because infrastructure-related problems have sharply limited the penetration of e-business technologies in Indian firms. Indian IT firms have substantially contributed to foreign exchange and created huge employment opportunities. The results of the study show that the growth of employment in sample firms ranges from 34 to 48 per cent since 1994–95. The Indian IT sector in general has recorded the highest growth after the liberalization of Indian economy. Indian producers of e-business technologies have been concentrating on customized rather than packaged software solutions. This focus could be due to lack of experience, required expertise and the competition from MNCs such as SAP, although they have made satisfactory progress in customized software products and services. Despite the modest size of their contribution to the GDP, the Indian IT industry has a visible impact on the Indian economy.

8.3.2 Consumers

8.3.2.1 Performance

Until the 1990s, the domestic market had been protected for Indian companies in the consumer electronics sector, and so competition in this sector was quite limited. This scenario changed in the 1990s when the domestic market was opened for foreign firms. Several large firms disappeared from the market, as they could not withstand the competitive

pressure in the new environment. The Indian companies who responded to the new environment by adopting new technologies could survive and face new challenges. The firms discussed in this study have not only survived, but have improved their performance in the domestic and international markets even though the MNCs, such as LG and Samsung, that entered into Indian market enjoyed technological advantages as well as reputation and brand name. The impressive growth sales turnover of the sample firms suggests that the adoption of ICTs has enabled firms to remain in the market and has been catalytic in improving their performance.

8.3.2.2 Employment

The general impression is that the productivity gains of ICT adoption derives from the retrenchment of the workforce. Literature on the subject suggests that the adoption of ICTs is not always focused at productivity gains, but could also be aimed at appropriating other benefits of new technologies. However, some studies (Kramarz, 1998; Doms et al., 1997) find evidence of structural changes in employment. The results of this study show that there has been significant growth of employment in all the sample firms; however, we have not been able to analyse the impact of e-business technologies on the structural changes in employment. Discussions with the companies suggest that the major growth in employment has been for skilled workers. In general, the study does not find any evidence to suggest that the adoption of e-business technologies results in the loss of jobs.

8.4 Summary

The study aims at analysing the pattern of e-business technologies adoption in large corporations in India and its impact on employment. A case study method has been used to examine various issues related to the use of e-business technologies in three sectors: ICT-producing firms, consumer electronics firms and the garments manufacturing industry. The firms that formed the basis of our case studies were considered the top firms in their respective sectors. They were selected based on their fiscal performance over the period 1994–2004, a fiscal period of nine years that was the source of the data used in the analysis.

The findings of the study suggest that the pattern of adoption of e-business technologies is not uniform across industries. However, the pattern of adoption within sectors has been similar. The consumer electronics sector firms adopted these technologies in almost all

business activities including production, marketing, co-ordination, supply chain management and customer relation management, whereas garments manufacturing firms adopted e-mail and internet for interacting with buyers and CAD/CAM technologies in manufacturing process. Common in both the sectors is the adoption of B2B e-business models. However, the B2C model has been neglected by all the sample firms, surprisingly even by those in the consumer electronics sector. The firms attributed socio-economic factors and lack of institutional infrastructure as the rationale for not adopting the B2C model.

The data provided by sample firms suggest that the adoption of these technologies has enabled the firms to survive in both the domestic and international markets, and has contributed to a better performance. The firms started adopting new technologies after the liberalization of Indian economy in 1991, possibly due to competitive pressures from the MNCs that were allowed to enter into the Indian market in the same period. In addition to achieving a high growth rate, the employment opportunities have increased significantly. The average growth of sales turnover of the sample firms has been 25 per cent, while employment at the firm level has registered a growth rate of 13 per cent since 1994–95. All the sample firms reported that the adoption of these technologies has also created varying levels of indirect employment corresponding to the firms' size and industry. These findings are in accordance with the existing literature (Hecker, 2001; Kramarz, 1998; Lal, 1996, 2002). The findings of this study suggest that concepts of resource-based theory and the role of competition can contribute in understanding the adoption of e-business technologies.

However, the study provides no evidence to suggest that the use of new technologies affects a firm adversely. Nevertheless, the adoption of ICTs could lead to change in the employment structure as ICTs create skill-biased technological change (Doms et al., 1997). The impressive growth rate of sales turnover and employment of sample firms may not be solely attributed to the adoption of e-business technologies. Other measures taken since 1991, such as simplified procedures for the import of raw material and machinery, might have also contributed. Hence, the findings of the study need to be interpreted against the backdrop of other economic policies. Another limitation of the study, due to the small sample size, has been the lack of a statistical test of the significance of factors that influenced the adoption of e-business technologies. Further research is needed to examine the impact of e-business technologies on firm-specific factors such as productivity, quality improvement, conduct of firms and so on.

Appendix A Product and e-business technology profile of firms

Firms	Home country	Average percentage of exports to total sales turnover during 1994–95	Products and services	E-business technologies adopted by the firm
Technology producers				
Wipro	India	70.9	IT hardware, professional services, communication services; B2B solutions (SCM and CRM)	WAN, LAN, B2B, B2C, CRM, portal-based technologies
Infosys Technologies	India	98.5	Software products and services	WAN, LAN, B2B, B2C, CRM, portal-based technologies
Satyam Infoway	India	4.5	Internet and e-business software products	WAN, LAN, B2B, B2C, portal-based technologies
Technology users				
Videocon	India	2.86	Consumer electronics Internet	WAN, LAN, ERP, MRP, B2B,
BPL	India	4.47	Consumer electronics Internet	WAN, LAN, ERP, MRP, B2B,
Orient Crafts	India	100	Garments CAD/CAM, B2B, Internet	WAN, LAN,
Gokaldas Images	India	100	Garments CAD/CAM, B2B, Internet	WAN, LAN,
Sonal Garments	India	100	Garments	LAN CAD/CAM, B2B, Internet

Note : CRM, customer relation management; WAN, wide area network; MRP, manufacturing resource planning.

9

New Technologies and Export Performance of SMEs[21]

9.1 Introduction

The policies adopted by developing countries in relation to international trade have always played a crucial role in their social and industrial development. In recent years, a number of developing countries have been able to strengthen their comparative advantage by focusing on building technological capability, on new technology adoption and on the development of skills to use these new technologies effectively and efficiently (Noland, 1997). Several studies (Trefler, 1993, 1995; Moreno, 1997) have demonstrated the importance of technological differences in international trade. Moreno (1997) found that technology had a significant effect on the evolution of Spanish industrial exports. The study suggests that non-price factors, such as product quality and product differentiation, exert a significant influence on international competitiveness.

The last decade of the twentieth century has witnessed further technological changes largely led by ICTs, which are considered the most pervasive technologies. Their applications are not only limited to shop floors, but can also be used for non-production processes such as product design, marketingand after-sales support among other functions. Hence, they are considered significant non-price factors of competitiveness. Several scholars argue (James, 1994; Domset al., 1997) that ICTs can substantially contribute to an augmentation in product quality and product differentiation and hence influence the competitiveness of firms.

ICTs have been widely adopted by various types of firms engaged in the manufacturing and service sectors in both developed and developing nations. The justification for their adoption includes the perceived links between ICTs and gains in productivity (Kraemer and Dedrick, 1994; Lichtenberg, 1995), improvement in product quality and

increased flexibility in manufacturing processes (Lal, 1996). Much of the literature on this subject addresses factors that determine the adoption of ICTs (Brynjolfsson and Hitt, 1996; Domset al., 1997; Lal, 1999a). By contrast, using case studies of Indian firms, we analyse the consequences of the use of e-business practices on export performance.

In essence, e-business fosters organizational innovation, enabling firms to enter new and changing markets. Through e-business, companies reshape their market presence and the manner in which customers buy their products and services. Through the use of ICTs, firms can reach new customers more efficiently and effectively, thereby transforming the mode of exchange of goods, services, information and knowledge.

This chapter investigates consequences of the adoption of e-business rather than e-commerce. The study's two main objectives are as follows: first, to identify and analyse the factors that influence the adoption of e-business by -SMEs in India, and second, to examine the consequences of adoption on export performance. SMEs were selected for the study as they constitute a major source of employment and foreign exchange.

9.2 Analytical framework

E-business has the potential to benefit firms operating in the domestic market as well as export-oriented firms, and in this chapter we focus on the export performance of SMEs. Adoption of e-business for export promotion is a function of several factors, and in many cases, these factors mutually reinforce each other. Figure 9.1 depicts the interaction between the export performance and the adoption of e-business.

Source: Adapted from Lal, K., "E-business and export Behavior: Evidence from Indian firms", World Development, 32(3) (2004), 505–17.

As Figure 9.1 shows, international orientation factors – represented by imports, exports, technological and financial collaboration and the adoption of e-business – mutually reinforce each other. For instance, the adoption of e-business may be imperative to augment exports through increased interaction with foreign buyers, and in turn larger exports might provide the additional resources needed to use e-business more extensively. Similarly, sales turnover and the adoption of e-business are expected to influence each other. This holds true for the adoption of e-business as it does for any innovative activity carried out on the shop floor.

A major prerequisite for the success of e-business is the existence of a very strong and reliable communications network. Access to a higher

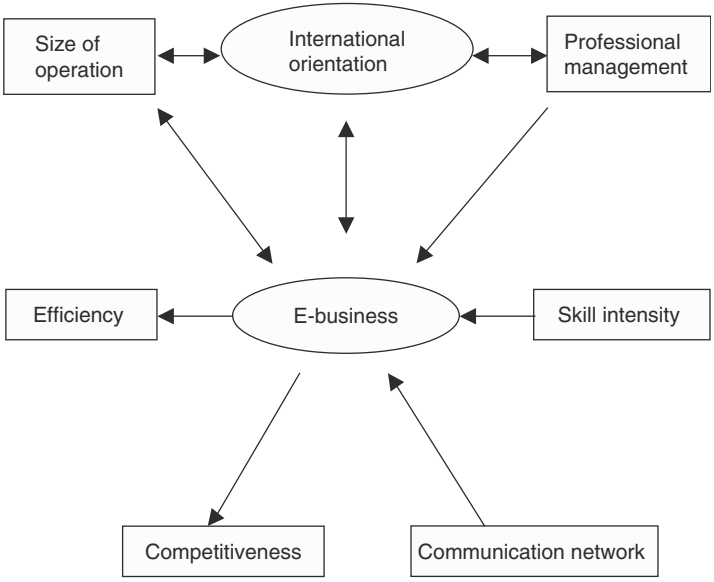

Figure 9.1 Export performance and e-business linkages

bandwidth is not within the control of individual firms, but forms part of the institutional infrastructure. Realizing the important role that higher bandwidth plays in the success of web-enabled services, greater emphasis has been laid on the privatization and deregulation of telecommunications services in developing and developed countries. Conduct variables such as skill intensity of firms, investment in R&D, and wage rates are important factors that are expected to have bearings on the adoption of e-business. Higher remuneration is always a major incentive for the workforce to create and adopt innovations effectively and efficiently.

With regard to the consequences of the adoption of e-business, the literature cites numerous benefits obtained from its adoption (Bedi, 1999; Damaskopoulos and Evgeniou, 2003; Hodgkinson and McPhee, 2002; Drew, 2003). These benefits range from employment to productivity gains, consumer surplus and improvement in product quality. Firms might adopt e-business because of its perceived impact in reducing co-ordination costs. However, as depicted in Figure 9.1, many more benefits

exist. Due to the increasingly inexpensive access to global markets and information on the Internet, it is fast becoming the world's largest and most versatile marketplace for services, products and information. E-business enables firms to reevaluate the ways in which they do business and redefine their existing business infrastructure. It could further lead to the re-engineering of business processes across the boundaries that have traditionally separated suppliers from their customers. Previously discreet activities such as order processing, payments and after sales services may be merged into a single process. This would result in reducing the costs of creating, moving, processing and managing documents.

E-business is also expected to reduce operational costs since electronic information tends to be more accurate, timely and easily available (Damaskopoulos and Evgeniou, 2003). Another benefit of e-business could be the higher efficiency obtained in business transactions due to a fast and accurate processing of information. Web-enabled services are likely to strengthen the competitiveness of firms as these technologies change the relationship with customers by creating a stronger link between firms and their clients.

9.3 Data and methodology

The study is based on primary data collected from firms located in NOIDA and Okhla that is described in Chapter 2. All the firms located in these clusters were approached and the response rate was roughly 70%. Firm-level historical, financial and technological data was collected through a semi-structured questionnaire during the period from June 2002 to January 2003. Historical data included the background of the MD and the age of the firm, whereas financial data (2001–02) consisted of sales turnover, investment in ICTs, wage bill, exports, imports, profit after tax and value added. Technological data included the types of e-business tool adopted and the bandwidth used by firms. Data on technological and financial collaborations with multinational companies were also collected.

The type of ICTs adopted by firms determines the intensity of e-business technologies. The survey shows that firms mainly employed the following technologies: FMS, CNC, CAD/CAM, E-mail, MIS and web- and portal-enabled technologies. The sample firms were grouped into three categories depending on the type of technologies adopted by them. The quantitative definition of type of technology used for e-business is discussed Section 9.5. In addition, sample firms were also classified

according to their market preferences. Firms doing business largely in the domestic market were labelled non-exporting-units (NEUs), while those that were present in the domestic as well as in export markets are classified as exporting-units (EUs). Firms operating only in international markets are labelled export-oriented-units (EOUs).

This chapter uses Tobit analysis, a censored regression model, to identify factors that influenced the export performance of firms. A censored regression model was used because the dependent variable, that is, export intensity, takes values between 0 and 1. Export intensity was computed as the ratio of exports to the total sales turnover.

9.4 Hypotheses

Drawing upon the theoretical and empirical evidence on the adoption of ICTs and the consequences thereof, we now proceed to formulate the hypotheses concerning the export intensity of firms and other variables. The hypotheses concerning all the variables included in the analysis are discussed below in detail.

9.4.1 Intensity of e-business technologies

This is a discrete variable and bases the assigned values on the type of technology used for e-business by the sample firms. As explained in the previous section, all the sample firms have been grouped into three categories depending on the means of e-business transaction they adopt. The variable EB_INT has been assigned value 1 to the firms using e-mail and office automation tools. Firms using e-business technologies in production processes have been assigned value 2, while EB_INT has been assigned value 3 for firms using portals and the web. Table 9.1 presents the descriptive statistics of conduct and performance variables of firms according to the use of e-business technologies. The table shows that performance of firms using portals in the domestic market as well as in international markets is higher than those that were using other tools.

Empirical findings on the relationship between exports and the adoption of new technologies have been mixed. Lal (1996) used expenditure on R&D as a proxy for technology and found it negatively significant in explaining export performance of engineering and chemical firms in India. Although neo-technology theory highlights the role of the technology gap in determining a country's international trade (Vernon, 1966; Krugman, 1979), the empirical findings of several studies (Kumar, 1990; Cotsomitis et al., 1991) suggest that the technology variable has no role to play in export performance. Cotsomitis et al. (1991) used technology

Table 9.1 The adoption of e-business, conduct and performance of firms

Variable	E-business Technology			
	Eb_eo	**EB_p**	**EB_pu**	**Total**
Size of operation (in million rupees)	77.6210 (558.977)	176.7210 (985.284)	383.7040 (3611.350)	126.6200 (1635.925)
Skill intensity	0.0097 (0.011)	0.0109 (0.008)	0.0114 (0.012)	0.0100 (0.011)
Exports (in million rupees)	69.8640 {27} (545.467)	106.7790 {7} (500.931)	214.0460 {19} (2196.243)	126.4280 {53} (1516.316)
Profit margins	7.4130 (2.216)	8.1340 (2.877)	10.4590 (2.883)	7.8580 (2.577)
Value added (in million rupees)	16.7840 (119.577)	38.4340 (219.843)	90.2810 (810.434)	28.2060 (373.761)
Total no. of firms	169 [73.16]	37 [16.02]	25 [10.82]	231

Note: Figures in parentheses are standard deviations, while those in square brackets are row percentages and figures in curly brackets present the number of exporting firms.

stock and Kumar (1990) used R&D intensity as a technology variable in the analysis. In recent years, however, several studies (Kumar and Siddharthan, 1994; Basile, 2001) have concluded that the technology variable, measured in terms of R&D expenditure, emerged as an important factor in explaining the export performance. In view of the findings of earlier studies and the characteristics of sample firms presented in Table 9.1, we hypothesize that e-business technology will emerge as an important factor that influences the export performance of firms.

9.4.2 Firm size

Sales turnover in million rupees is used as a proxy for size of firms. However, in the Tobit analysis, size of operation in billion rupees is considered. Table 9.2 presents the distribution of size of operation according to export performance of firms. A noticeable fact shown in Table 9.2 is that productivity, performance and profitability of EOUs is higher than NEUs, but less than EUs. This is true with regard to skill and e-business technology intensities. This suggests that EU firms are better positioned in terms of their conduct and performance. However, this may not be true. A possible reason for EUs experiencing high profitability

Table 9.2 Univariate analysis of variables

Variable	**Mean and SD of variables**					
	Firms			***F*-value**	**Probability**	**Remarks**
	NEU	**EU**	**EOU**			
SKILL	0.0106 (0.0108)	0.0159 (0.0096)	0.0055 (0.0096)	6.024	0.003	Ratio of BE+MBA to the total workers
STO	101.6450 (923.527)	338.4240 (4469.793)	164.5780 (1605.109)	16.914	0.000	Sales Turnover in million rupees
EB_INT	1.2400 (0.499)	2.0700 (0.997)	1.7700 (0.902)	21.1200	0.0000	E-business technology intensity
Labour productivity LABPROD	21.8090 (204.651)	78.3490 (1038.767)	39.3990 (395.789)	19.7140	0.0000	Value added per worker in thousand rupees
profit margin PRM	7.4350 (2.099)	10.1690 (4.005)	8.9610 (3.185)	12.7860	0.0000	Profit Margins

Note: Figures in parentheses are standard deviations.

than EOUs is the existence of few auto-components manufacturing firms in the sample. EOUs are largely garments manufacturing firms, whereas EU firms are component suppliers to several MNCs such as Hyundai Motors and Daewoo Motors, and thus earn comparatively higher profit margins. Although such auto-components manufacturing firms are classified among EUs, their export intensity is less than 10 per cent. Profitability and performance of garments manufacturing firms are generally low due to the sector's absence of entry barriers. On the other hand, auto-components manufacturing is considered capital intensive, which raises the entry barrier and consequently results in higher profitability and performance of existing firms. There are hardly any of the electrical and electronic goods manufacturing firms operating in international markets.

Table 9.2 shows that, in general, the size of operation displays an increasing trend with the export performance of the sample firms. The table also shows that average size of operation of NEU is Rs 101.645 million, while that of EU is Rs 338.424 million. Although the size of operation of EOUs is between NEUs and EUs, the slope of the trend line between export intensity and size of operation is positive. This is because EOUs have a higher size of operation than NEUs. Results presented in Table 9.2 show that size of operation varies significantly among the three categories of firms.

The literature considers size of operation as the resource that enables a firm to venture into international markets. Firms with a larger size of operation enjoy greater risk-bearing capacity, brand names, and price-setting power (Krugman, 1979). A study by Glejser et al. (1980) reported a negative impact of size on exports, while several other studies (Haddad et al., 1996; Abd-el-Rahman, 1991) have found positive effects on exports. A study by Hughes (1986) found no effect of size on export performance of firms. Several studies (Kumar and Siddharthan, 1994; Lall, 1986) found mixed effects, depending on the industry and measure of export, whereas Wakelin (1997), Kumar and Siddharthan (1994), and Willmore (1992) concluded that the size-export relationship was an inverted 'U' in which the gains from size diminish with increasing size. As the sample firms are neither very small nor large corporations, we hypothesize that size might emerge as an important determinant of the export performance of firms.

9.4.3 SKILL

SKILL has been computed as the ratio of workers that have professional degrees such as BE, MBA and Chartered Accountant (CA) to the total

workforce. Table 9.2 presents the distribution of firms according to their skill intensity and export performance. As the table reveals, skill intensity is significantly different in all three types of firms. It can be inferred from the table that skill intensity is positively associated with export performance of firms. However, it is notable that the skill intensity of EOUs is 0.0055, the lowest level compared to other firm categories. As discussed earlier, the dominance of garments manufacturing firms in international markets could be a possible reason for this behaviour. Garments production is a traditional sector dominated by skilled labour, rather than professionals with formal qualifications.

Lucas (1988) and Azariadis and Drazen (1990) have built theoretical models in which export performance is driven by human capital. However, several empirical studies report conflicting results with regard to the relationship between skill intensity and export performance. Kumar and Siddharthan (1994) did not find any impact of skill on exports in several industries in India, although they did find that skill was an important factor in the export performance of the food processing and transport equipment industries. However, a macro level study by Levin and Raut (1997) found a positive and significant relationship between export performance and investment on education in developing countries. The findings of several studies (Lal, 1996; Bernard and Wagner, 2001) also suggest that plants intensive in skilled workers are more likely to export. In view of the theoretical and empirical evidence, we hypothesize a positive relationship between export performance and skill intensity.

9.4.4 Labour productivity

The variable has been computed as the ratio of value added to total workforce; however, the Tobit analysis considered and value added in million rupees. Table 9.2 presents the distribution of labour productivity according to market preferences of firms. It seems that labour productivity follows a similar trend as skill intensity and size of operation. Labour productivity is lowest (Rs 21,809) in NEUs, whereas it is highest in EUs (Rs 78,349). This was also the highest in all categories of firms classified by the market preferences.

Empirically, the relationship between labour productivity and export performance has been found to be ambiguous. Lal's (1999b) study of export performance in the Indian garments industry did not find any evidence of a significant difference in the labour productivity of exporting and non-exporting plants. The author attributed this phenomenon to the fact that non-exporting firms are sub-contractors to export-oriented

firms. Sjoholm (1999), however, found that establishments participating in exports have relatively high productivity levels in Indonesia. A recent study by Bernard and Wagner (2001) suggests that labour productivity was positively significant in influencing the export behaviour of firms. As argued in the theoretical framework presented in Section 9.2 and in view of the findings of earlier studies, we expect that the export-oriented firms are likely to be more productive.

9.4.5 Profit margins

This variable has been computed as the ratio of profit after tax to sales turnover. Table 9.2 shows the distribution of profitability according to the market preference. The table reveals that profit margins are lowest (7.4 per cent) in domestic market–oriented firms, while the average profitability of EOU is 8.96 per cent. This is a higher profitability than NEUs, but lower than EUs (10.17 per cent). The association of profit margins with export performance is similar to that of other variables discussed earlier.

The use of new technologies is expected to reduce costs in activities other than manufacturing, which should reflect in higher profit margins. Until the early 1990s, studies did not find empirical evidence to support the argument that firms using advanced ICTs earned higher profit margins than those that did not. However, after the mid-1990s, studies (Brynjolfsson and Hitt, L., 1996; Pohjola, 2001) found evidence of positive association between profit margins and the degree of ICTs adopted. We also expect that the profitability of export-oriented firms is higher than others. The mastery of a technology requires explicit efforts and continuous learning. Firms in the early years of adoption had to learn to acquire the necessary technical capabilities.

Since our focus is to examine the impact of ICT adoption on the export performance of firms, we used export function rather than technology diffusion models. Following several other studies (Aitken et al., 1997; Moreno, 1997; Hughes, 1986), the form of the export function used in this study is presented in Equation 9.1.

$$\text{Exi} = \alpha + \beta 1\ \text{EB-INTi} + \beta 2\ \text{SKILLi} + \beta 3\ \text{STOi} + \beta 4\ \text{LABPRODi} = + \beta 5\ \text{PRMi} + \varepsilon i \quad (i=1,nf) \qquad \text{(Equation 9.1)}$$

Where, *nf* is the no. of sample firms; *Exi* the export intensity; *EB-INTi* the level of IT adoption; *SKILLi* the monthly wages paid *STOi* the sales turnover *LABPRODi* the value added per worker and *PRMi* the technological collaboration.

9.5 Statistical results

All the variables discussed in the last section were analysed in a univariate framework. The mean value and standard deviation of these variables aere presented in Table 9.2, along with the *F*-value and the level of significance. It was observed that the mean values of the variables such as SKILL and EB_INT differ very significantly among the three types of firms. The other variables such as STO, PRM and LABPROD also differ significantly among these categories of firms.

Subsequently, for the reason given earlier, a censored regression model, Tobit, was used to identify the determinants of the export performance. Table 9.3 presents the maximum likelihood estimates of three different models. We tried several equations because of multicollinearity in independent variables. Coefficients of size and labour productivity have been estimated separately due to high correlation with other explanatory variables. The results are presented in Models II and III respectively. In Equation I, all the variables except size and labour productivity were included in the analysis. The results show that SKILL, EB_INT were significant at 1 per cent while PRM was at 5 per cent. Although skill intensity emerged as significantly different among the three categories of firms, contrary to our expectations, the relationship emerged as negative.

Table 9.3 Maximum likelihood estimates of export performance (Tobit model)

Dependent variables	**Model I**			
	coefficient	***z*-ratio**	**marginal effect**	***z*-ratio**
Constant	−1.8960	−4.939**	−0.4060	−5.853**
SKILL	−25.2850	−2.868**	−5.4140	−2.888**
EB_INT	0.4840	3.612**	0.1040	3.630**
PRM	0.0862	2.420*	0.0185	2.433*
Log likelihood		−140.0266		
	Model II			
Constant	−1.0382	−5.116**	−0.2408	−7.869**
SIZE (in billion rupees)	1.392	2.602**	0.3230	2.634**
Log likelihood		−154.9035		
	Model II			
Constant	−1.0593	−5.205**	−0.2439	−8.071**
LABPROD	0.6990	2.981**	0.1610	3.019**
Log likelihood		−153.6631		

*significant at 5 per cent.**significant at 1 per cent.

The negative relationship between export intensity and skill intensity could be attributed to the sector-specific characteristics of sample firms. As mentioned earlier, firms in the garments manufacturing sector, which is considered labour intensive, dominate the export-oriented sample firms. Moreover, in this sector, only the design, pattern and marker-making stages of garments manufacturing require a skilled workforce. The proportion of employment in these stages represents a fraction of the total number employed in garments manufacturing. However, the electrical and electronic goods manufacturing sector is knowledge- and capital-intensive. The fact that most enterprises in the knowledge-intensive sector operate in the domestic market has contributed to higher skill intensity of NEU firms. This has resulted in a negative relationship between skill intensity and export performance of firms. Although several earlier studies (Helleiner, 1995; Bernard and Wagner, 2001) found that firms that employ skilled workforce are likely to export more, the results of this study does not support these findings.

Table 9.3 shows that the intensity of e-business adoption has played a significant role in influencing the export performance of firms. Wakelin (1997) argued that firm- and industry-specific characteristics determine export performance. The arguments neither dispute the factor intensity theory nor challenge the theory of comparative or competitive advantage. However, technological innovations and adoption have been widely used to explain the variations in export performance. For instance, in science-based sectors, innovative capabilities are very important, whereas in labour-intensive industries, such as footwear and clothing, the adoption of new technologies plays a crucial role (Dosi et al., 1990; Abd-el-Rahman, 1991). The application of ICTs, such as CAD/CAM, in footwear and clothing industries enable firms to alter designs more frequently than those made by traditional methods. The ability to make frequent changes in product designs is very important for firms that deal in international markets. The new technologies also contribute to better co-ordination of activities with buyers in general and foreign buyers in particular. Our findings confirm the position of the existing literature regarding the differential export performance and the technological capabilities of firms.

The adoption of new technologies is often aimed at augmenting labour productivity. A study by Kraemer and Dedrick (1994) suggests that new technologies are aimed at improving productivity, particularly in developed countries. Several recent studies (Lal, 1996; Bernard

and Wagner, 2001) have found evidence that the labour productivity of export-oriented firms is higher than that of others. The productivity gains come mainly from the adoption of advanced technologies in general, and ICT-led technologies in particular. Pohjola (2001), in his cross-country study of ICT and productivity, also found evidence of productivity gains due to the adoption of ICTs. Mohnen (2001) concluded that widespread use of e-business would lead to a greater participation in the globalization process. The emergence of higher productivity in the export-oriented firms considered in this study supports the findings of these earlier studies. The marginal effect of labour productivity suggests that an increase in labour productivity by one million rupees from its mean value of Rs 28,206 can augment the export intensity by 16.1 per cent.

The emergence of size of operation (STO) as a significant variable in determining the export performance of three groups of firms is in line with the existing literature. Table 9.3 shows that a change in STO by one billion rupees. from its mean value (Rs 126.620 million) can increase exports intensity by 32.3 per cent. A study by Pavitt et al. (1987) also found a positive relationship between the adoption of new technologies, which is a prerequisite for better export performance, and the STO. In terms of investment in new technologies, firms that have a large STO are comparatively better off. Moreover, large firms are in a better position to appropriate the benefits of innovations in domestic as well as overseas markets. Sound financial position and appropriability conditions have strong bearings on the adoption of the latest technologies and in the investment on innovative activities, which is very important to remain competitive in the international markets.

The results of the study also suggest that export-oriented firms earned higher profit margins than firms operating only in the domestic market. Higher profit margins are major incentives for SMEs to conduct business in export markets. Export-oriented firms in India are expected to earn greater profit margins compared to firms operating in the domestic firms due to such export incentives as duty drawback. In duty drawback, those firms in India that are 100 per cent export oriented are rebated a percentage of sales turnover as the duty paid on the imported raw material used in the production processes. In principle, it should be paid based on the actual duty paid on imported raw material; however, firms are actually paid back a fixed percentage of sales turnover (reviewed annually) in order to avoid archaic procedures involved in the computation of actual duty paid. The results are in accordance with the existing literature (Helleiner, 1995).

9.6 Summary

The paper identifies and analyses the factors that have influenced the export performance of firms. The data was drawn from firms located in NOIDA and Okhla. Sample firms belonged to three sectors: garments manufacturing, auto-components manufacturing, and electrical and electronic goods manufacturing. SMEs largely dominated the samples. All the firms located in these clusters were approached, with a response rate of roughly 70 per cent. Firm-level historical, financial and technological data were collected through a semi-structured questionnaire during the period from June 2002 to January 2003. Historical data included the background of the MD and the age of the firm. Financial data (2001–02) consisted of sales turnover, investment on ICTs, wage bill, exports, imports, profit after tax and value added. Technological data included the type of e-business tools adopted and the bandwidth used by firms. Data on technological and financial collaborations with multinational companies were also collected. Firm-specific factors such as size of operation, intensity of the adoption of e-business technologies, skill intensity, labour productivity, international orientation, wage rates and profit margins were included in the analysis.

Tobit, a censored regression model, was used to identify determinants of export performance of firms. The study's results show that the type of technology used for e-business and the profit margins were significant factors found to influence the export performance of firms. The scale of operations also emerged as a significant determinant of export performance. The study reveals that the labour productivity of export-oriented firms was higher than that of non-exporting units. The findings of the study are largely similar to other studies (Doms et al., 1997; Bedi, 1999; Pavitt et al., 1987; Bernard and Wagner, 2001).

The study captures the important role played by the type of technology used for e-business by the sample firms in influencing their export performance, although identification of the various factors that influence the adoption of e-business technologies is beyond the scope of this paper. Several studies (Lal, 2001; Mehta, 2000), however, suggest that communications technology network is a driving force behind the diffusion of e-business. The study by Lal (2001) found that the diffusion of e-business is strongly associated with the bandwidth. A study by Mehta (2000) suggests that availability of higher bandwidth is a prerequisite for the penetration of the Internet and web-enabled services in India. The findings of this study suggest that governments need to create the

right environment for greater diffusion of e-business technologies that in turn could augment the export performance of firms.

The implications of the study's findings are twofold. One, an appropriate environment for the effective adoption of e-business has to be in place. The limited use of e-business will have serious repercussions on the performance of firms in international markets. If Indian firms that deal in international markets are unable to strengthen their e-business applications in areas such as online financial transactions and monitoring of status of consignments, they are likely to lose foreign partners. Although the GOI has taken several measures to encourage greater diffusion of ICTs, reliable access to high-speed communications networks at competitive prices should enhance the diffusion of e-business technologies, which is in turn likely to influence export performance. The formulation and enactment of communications technology convergence regulations can facilitate access to a broad range of communications networks. For instance, if last mile connectivity is allowed through the cable network, which is primarily meant for video communications, it could trigger an explosive adoption of e-business. The GOI can also encourage the adoption of this new technology among export-oriented firms by continuing export incentives such as tax holidays on the value of goods and services traded electronically.

The second implication relates to policies on collective learning and training facilities aimed at SMEs. The study has shown that the incorporation of e-business practices, coupled with a high skilled workforce, can enable firms to perform better in export markets. Hence, policymakers need to target learning and training facilities for SMEs. Providing logistical support to industry associations located in SME clusters can achieve this objective. In turn, industry associations can take advantage of an 'industry–university link' programme initiated by the GOI to produce a skilled labour for SMEs. We conclude, therefore, that it is imperative for the Government of India to provide proper institutional support to export-oriented firms for the effective use of e-business, which would strengthen export performance. Based on the findings of this study, India must take proactive measures to speed up the adoption of e-business or risk losing its export share in the international markets.

10
Conclusions

SMEs make up close to 80 per cent of businesses in developing countries and therefore represent the best hope for generating strong local and regional economies. However, SMEs often tend to operate with obsolete technology and constrained by low skills, finance and poor access to information. The emergence of new technologies in the form of e-business tools carries with it the promise to revolutionize the ways in which SMEs carry out production, innovation and marketing. This book advances the argument that the adoption of ICTs is likely to promote greater productivity within the enterprises. However, the effective use of e-business tools at the enterprise level is strongly conditioned not by a single factor, but the availability and interaction of a host of external elements such as access (broadly defined), diverse range of skills, telecommunications network and good physical infrastructure. In what follows, we provide an overview of the main findings of the book.

10.1 Sector and size structure

Although we were unable to map all sectors across countries, the results presented in Chapter 3 on the sectoral impact of new technologies suggest that there are industry-specific factors that influence the degree of the adoption of e-business technologies. The intensity of adoption of e-business technologies in the skill and knowledge sectors, such as the electrical and electronic goods sector, was found to be higher than in labour-intensive sectors such as garments, auto-components manufacturing and food and beverages. Another factor derived from the skill intensity of a sector, the knowledge and academic qualifications of MD or owner, appears to have played an important role in influencing the intensity of new technologies adoption.

In addition, the results show that the intensity of e-business tool adoption was not affected by factors such as profitability, size of operation, age of firm, and per capital investment at the industry level. However, there are significant variations in the conduct and performance of firms that were using the lowest levels of e-business tools from the more advanced users of new technologies within an industry.

10.2 External and internal e-business technologies

Certain factors emerged as major determinants of the intensity of internal e-business technology adoption. In this book we make a distinction between external technologies (those that are needed for e-business but beyond the control of individual firms) and internal e-business technologies (tools that are acquired, implemented and managed by firms).

Quantitative and qualitative analyses show the considerable country differences in the variables that emerged as significant in influencing the intensity of e-business technology. For instance, in India, with superior network and telecommunications facilities, the key determinants of e-business adoption in Indian firms were size of operation, export performance, profitability, value addition, skill intensity and academic qualifications of the MDs. However, Uganda firms were influenced by skill intensity, size, profitability, learning processes and technological collaboration with foreign firms. Comparatively, the factors that emerged as significant for Nigerian firms are the knowledge base and academic qualifications of the MDs, skill intensity, internal competition and learning opportunities.

What these mean is that what tend to influence firms' propensity to adopt e-business at any historical period reflect the country's technological infrastructure, human skills and capabilities. One of the major implications of our study is the required emphasis on formal training in addition to on-the-job training. India recognized this need and over the last two decades established a network of training institutions in the various Indian economic zones to provide the requisite skills to build a bridge between formal knowledge and informal factory-level skills. In both Nigeria and Uganda, a vibrant private ICTs business services sector has emerged, and although Nigeria seems to be far ahead it is less advanced and much less organized compared to the training culture in India. The role of the state has certainly proved beneficial and points the way to the potential for private–government partnerships. In this model, the governments provide logistic support to private institutions to establish training centres in industrial clusters. There is now considerable empirical evidence

that close proximity of manufacturing firms to training institutions in such cluster settings has the advantage of facilitating practical training to trainees (Piscitello and Sgobbi, 2004).

Another recommendation of the study is that providing technological and marketing support to firms in developing countries would enhance their ability to compete in international markets.

This can be achieved by setting up separate export promotion councils at the sectoral level. These councils perform functions such as assisting small firms in exhibiting their products, providing information on market trend, and tendering legal services in case of disputes. Export promotion councils can also play a major role in augmenting export performance by assisting in the acquisition and implementation of the latest manufacturing technologies. Measures also need to be taken to encourage competition in domestic markets as strengthening competitiveness in the domestic market is expected to have a positive impact on a firm's global competitiveness.

Much remains in our understanding of the network determinants of small enterprise performance as a result of new technologies adoption. As discussed in the theoretical framework, there are bi-directional relationships among several factors that emerged as significant determinants of e-business technology adoption, although the study has not been able to identify all the causal relationships due to lack of time series data. A deeper understanding will be provided using the simultaneous equations model. However, it should be noted that the study identified the factors that influenced only one component of e-business technologies. For these reasons, further research is needed to identify and analyse the determinants of external e-business technologies.

10.3 Learning and skills effect of e-business adoption

One important conclusion that was systematically thrown up in the various chapters is the differentiated effects of wider sets of firm-level skill on the learning processes in SMEs in the three developing countries. We identified a pattern of adoption that shows clear relationships between internal firm variables and external infrastructure features that influence both the technological trajectories and firm-level performance. There is a certain gradation of adoption that displays skill-technology complementarity. There is net correlation between firms using advanced technologies and the education level of owners, and a consistent correlation between learning modes and complexity of ICTs in use. New types of SMEs called networked enterprises have emerged during

the last decade (Raymond et al., 1999). These firms conduct their production and marketing businesses relying to considerable degrees on Internet-mediated technologies. However, our study suggests that this phenomenon is not automatic; there is a strong association between the complexity of firm-level e-technologies and the level of national technological capability. There is considerable scope for institutional learning support for SMEs suggesting new and additional challenges for developing countries that, for now, have relatively weak institutions.

Regression results show the relationship between the learning processes adopted by the sample firms and technological trajectories followed by them. Several modes of learning such as in-house training, learning by doing, Internet searching, learning by interaction and overseas training were employed by firms depending on their level of development. The results of the study suggest that across countries and sectors, SMEs rely largely on learning by doing as the most effective first-order mode of knowledge and skills acquisition. However, the second choice of learning mode differs among sample countries. MDs of Indian firms employed Internet searching as the second best mode of learning, while in-house training was preferred in Nigeria and Uganda. This was traced to the fact that communications network facilities in Nigeria and Uganda are inadequate for effective use of the Internet and a reliable communications network significantly determines the adoption of new technologies. The study's findings also suggest that firms that adopted complex technologies had to employ relatively more skilled workers as well as use overseas training for effective use of such technologies.

Learning processes have also significantly influenced the technological trajectories of the firms, demonstrated in the ways firms in India adopted ICT-led technologies in production processes. For instance, several firms conducted transactions through web-enabled and portal-based technologies, while there was not a single firm that adopted such advanced technologies in Nigeria and Uganda. Two factors tend to shape the adoption of advanced technologies by Indian SMEs: the accessibility of stable Internet connectivity and the availability of requisite technological infrastructure in clusters. Reliable access to the Internet might have encouraged Indian SMEs in the sample to use Internet searching as the second best mode of learning. In contrast, firms in Nigeria and Uganda adopted technologies that do not require on line connectivity such as MIS, e-mail, CAD/CAM, CNC machines and FMS in order to minimize their dependence on external communications network. We therefore conclude that learning processes significantly influence the technological profile of firms. To this end, the

choice of learning processes depends on other external factors that are beyond the control of individual firms.

The chapter suggests several policy implications. First, SMEs need institutional support for their survival in the era of globalization. Second, human development policies aimed at SMEs need to emphasize both general and specific knowledge types and training; the adoption of advanced e-business technologies by Indian SMEs is a proof of this point. The GOI and the private sector shared the burden and the risk as the GOI encouraged private sector participation in the development of the industrial clusters' technological infrastructure. Consequently, SMEs in India have better access to web-enabled and portal-based e-business technologies relative to the two African countries. However, much still remains to be done by the GOI, which should take the initiative for providing uninterrupted utility services so that SMEs can become more competitive in international markets. Finally, we suggest that SMEs in Nigeria and Uganda need much greater infrastructural support in order to reap the benefits of ICTs and develop the capabilities to contribute to economic development. Proper policies and programmess aimed at providing required infrastructure need to be initiated in developing countries in order to make SMEs in developing countries more competitive in the domestic and international markets.

10.4 Technological and physical infrastructure

Supply side factors significantly impact on the adoption of new technologies in SMEs. Evidently, availability of physical infrastructure has been a severe constraint in the adoption of e-business technologies in all the three countries. However, there are significant differences with regard to technological infrastructure as represented by availability of Internet connectivity and speed of communications. Human knowledge and skills represented by availability of a computer literate workforce, abundant in India, emerged as an important impediment in the adoption of information and communication-led technologies in Nigeria and Uganda.

Six factors, availability of Internet connection, speed of the Internet, availability of skilled workforce, utilities, communications cost and Internet subscription cost, were included in the analysis. Results of multivariate analysis applied to sample firms suggest that all the factors, except the availability of trained workforce, has significantly influenced the diffusion of e-business technologies in India. Country-specific factors exert profound influences on the degrees of adoption of new technologies. For

instance, Nigerian firms using telephone and fax found Internet subscription a severe constraint, while 30 per cent of firms using similar communications technology in Uganda reported that it was not a constraint.

Results regarding communications cost and the diffusion of e-business technology in Nigeria and Uganda are very different. Many of the sample firms in Nigeria did not find cost of communications a major constraint, while it has been an impediment in Uganda. In Nigeria, firms were so desperate for communications technology? that access rather than cost had become the primary concern for them. Again, there are substantial differences in the supply of high-level labour, with Nigeria having considerably large numbers of scientists and engineers despite their being poorly organized for industrial purposes.

One of the major policy implications of the findings is that developing countries need to focus on institutions that support more efficient physical and technological infrastructure. In turn, efficient physical and technological infrastructure should reduce the cost of communications, which has been identified as a major bottleneck in the diffusion of e-business technologies. Privatization and deregulation of the communications sector might be an option to achieve this objective.

10.5 Collective services and competitiveness

Owing to the well known resource constraints faced by small firms, the provision of collective service is an alternative way of promoting enterprise-level growth and innovation. We investigated the role of collective service provision at different levels of new technologies use. We identified and analysed the factors that discriminate three groups of firms low level of ICT users, firms using moderate ICT and users of advanced ICT tools. Firm-specific factors included in the analysis fall into three broad categories: driving forces, collective actions and sources of competitiveness. The variables in the analysis include management information systems benefit, reduction in production costs, abilities of ICTs in increasing sales turnover, potential to strengthen competitiveness of firms, efficiency in production process due to adoption of ICTs, learning opportunities within industrial clusters, size of operation, technological collaboration, innovativeness, low overhead costs and wages, flexibility in product design and product quality.

The variables that discriminated firms using different levels of ICTs were the contribution of ICTs in reducing production costs, augmentation of sales turnover due to adoption of ICTs and internal competitive pressures. Among the sources of competitiveness that emerged as significant were

size of operation, technological collaboration, contribution of ICTs in manufacturing modular and high quality products, innovativeness and ability of ICTs in reducing overhead costs. For instance, wages emerged as an important factor in the Ugandan sample firms. The significant variables for Nigerian firms were reduction in production costs, availability of learning and upgrading opportunities within industrial clusters, size of operation and delivery schedule. The factors that emerged as significant discriminants of firms using varying degrees of ICTs in India were similar to that of Uganda. An additional factor, the contribution of ICTs in inducing efficiency in production processes, emerged as the most important discriminant of three types of firms. Among the sources of competitiveness, the ability of ICTs in strengthening the market network also discriminated firms using advanced ICTs from the others.

Ownership (shown in the opinion of MDs) is important to what kinds of e-business tools are adopted; so also is technical collaboration. This was poignantly illustrated in the way technological collaboration has been fostered with foreign firms in Indian sample firm since the liberalization of Indian industrial policies in 1991. With liberalization, Indian firms no longer required any license for collaboration. Market network emerged as a significant discriminant in Indian sample firms, and not in firms in the other two countries, due to the availability of relatively reliable communications network in India compared to the other two countries. The significance of low wages and low overhead costs as important discriminants in Ugandan firms suggest that, apart from quality competition, price remains a dominant mode of competition.

A number of policy measures to be taken by governments in developing countries to improve the competitiveness of SMEs are evident. First, state policy should encourage greater private sector participation in setting up training and information service centres within industrial clusters. These institutions could provide need-based skills for better usage of new technologies. Second, owners of small firms should be given incentives to upgrade the skills levels of their workforce. This could be done by organizing orientation programmes to raise the awareness of MDs related to new technologies. Also, there is need to subsidize the cost of new technology equipment so that new technologies become economically affordable to small firms. New technologies can be put within reach of small firms by setting up technology service organizations to provide, for instance, e-mail and Internet services. Setting up technological support institutions has many advantages in SME clusters. These institutions could be useful in searching function- and job-specific ICT tools that are expected to be efficient and cost

effective. Such collective cluster initiatives should result in better cluster performance.

Finally, the findings in this chapter suggest a need to create proper local, national and global information infrastructure in order for SMEs to derive the maximum benefit from the ICT revolution. Privatization and deregulation of the communications sector could improve local and national infrastructure, while allowing private and public sector organizations to own international gateways that can significantly improve the global information infrastructure. However, in underdeveloped areas, governments will have to take the lead in stimulating service provision.

10.6 Employment and e-business adoption

This impact of new technologies on employment was analysed using a qualitative case study approach to examine the pattern of e-business technologies adoption in large Indian firms. The issues related to the use of e-business technologies in three sectors, ICT producing firms consumer electronics and garments manufacturing industry. The firms that formed the basis of our case studies were considered the top firms in their respective sectors.

Our study found that the pattern of adoption of e-business technologies is not uniform across industries, but the adoption within sectors is fairly similar. The consumer electronics sector firms adopted these technologies in almost all business activities including production, marketing, co-ordination, supply chain management and customer relation management, whereas garments manufacturing firms adopted e-mail and internet for interacting with buyers and CAD/CAM technologies in manufacturing process. Common in both the sectors is the adoption of B2B e-business models. However, the B2C model has been neglected by all the sample firms, surprisingly even by those in the consumer electronics sector. The firms attributed socio-economic factors and lack of institutional infrastructure as the rationale for not adopting the B2C model.

Our analyses of firms' performance suggest that the adoption of these technologies has enabled the firms to survive in both the domestic and international markets and has contributed to a better performance irrespective of the measure. The firms started adopting new technologies after the liberalization of the Indian economy in 1991, possibly due to competitive pressures from the MNCs that were allowed to enter the Indian market in the same period. In addition to achieving a high

growth rate, employment opportunities increased significantly. The adoption of these technologies created varying levels of indirect employment corresponding to the firms' size and industry. The findings of this study suggest that concepts of resource-based theory and the role of competition can contribute in understanding the adoption of e-business technologies.

However, the study provides no evidence to suggest that the use of new technologies affects a firm adversely. Nevertheless, the adoption of ICTs could lead to changes in the employment structure as ICTs create skill-biased technological change. The impressive growth rate of sales turnover and employment of sample firms may not be solely attributed to the adoption of e-business technologies. Other measures taken since 1991, such as simplified procedures for the import of raw material and machinery, might have also contributed. Hence, the findings of the study need to be interpreted against the backdrop of other economic policies. Another limitation of the study, due to the small sample size, has been the lack of a statistical test of the significance of factors that influenced the adoption of e-business technologies. Further research is needed to examine the impact of e-business technologies on firm-specific factors such as productivity, quality improvement and conduct of firms.

10.7 E-business and export performance

The data on e-business and export, like those on employment are exclusively based on Indian data which analyse factors that influence export performance of firms. We concluded that the type of technology used for e-business and the profit margins were significant factors found to influence the export performance of firms. The scale of operations also emerged as a significant determinant of export performance. The study reveals that the labour productivity of export-oriented firms was higher than that of non-exporting units. These findings corroborate earlier studies.

The study captures the important role played by the type of technology used for e-business by the sample firms in influencing their export performance, although identification of the various factors that influence the adoption of e-business technologies is beyond the scope of this paper. Our study suggests that a good communications technology network is a driving force behind the diffusion of e-business and export success. This is confirmed by the study's findings that the diffusion of e-business is strongly associated with bandwidth. We therefore conclude that it is imperative to create a strong network environment for greater

diffusion of e-business technologies that in turn could augment the export performance of firms.

There are two implications of the focus on e-business and export performance. One, an appropriate environment for the effective adoption of e-business has to be in place. The limited use of e-business will have serious repercussions on the performance of firms in international markets. If firms that deal in international markets are unable to strengthen their e-business applications in areas such as online financial transactions and monitoring of status of consignments, they are likely to lose foreign partners. Although government in all the countries have taken some measures to encourage greater diffusion of ICTs, reliable access to high-speed communications networks at competitive prices should be a major objective. This factor enhances the diffusion of e-business technologies, which in turn promotes export performance. The formulation and enactment of communications technology convergence regulations can facilitate access to a broad range of communications networks. For instance, if last mile connectivity is allowed through the cable network, which is primarily meant for video communications, it could trigger an explosive adoption of e-business. Governments can also encourage the adoption of this new technology among export-oriented firms by continuing export incentives such as tax holidays on the value of goods and services traded electronically.

The second implication relates to policies on collective learning and training facilities aimed at SMEs. The study has shown that the incorporation of e-business practices, coupled with a highly skilled workforce, enables firms to perform better in export markets. Hence, policymakers need to target learning and training facilities for SMEs. Providing logistical support to industry associations located in SME clusters is one means of achieving this objective. In turn, industry associations can take advantage of linkage programmes such as the 'industry–university link' programme initiated by the GOI to produce skilled labour for SMEs. We conclude, therefore, that it is imperative for the governments to provide proper institutional support to export-oriented firms for the effective use of e-business, which would strengthen export performance. Based on the findings of this study, countries must take proactive measures to speed up the adoption of e-business or risk losing export share in the international markets.

Notes

1. The term information technology (IT) was used in studies carried out before the 1990s as the integration level of communications technologies with information technologies was not very high. After the 1990s, and particularly with the introduction of the Internet into the public domain, communication technologies have been increasingly embedded with information technologies. Consequently, they are referred to as information and communications technologies (ICTs).
2. See Indjikian and Siegel (2005) for a review of recent studies of the impact of ICTs on economic performance in developing countries.
3. The literature on cluster performance and innovation suggests that building up of the enterprise knowledge base in clusters results from the flow of knowledge from external as well as internal sources (Beaudry et al., 2000; Kline and Rosenberg, 1986; McCormick, 1998; Oyelaran-Oyeyinka, 2003). However, the creation and use of knowledge depends on the type of clusters. For instance, dynamic clusters use knowledge from external and internal sources of innovations and skill upgrading while less dynamic clusters rely heavily on external sources.
4. According to these authors, experience gained in the process of operating a given technology or new technology results in increased efficiencies and as such an educated workforce will be more amenable to learning complex technologies.
5. According to Piva et al. (2003), new forms of organization include decentralization and delayering ('lean production') examples such as just-in-time management, collective work such as 'quality circles' and multitasking which requires workers to master and perform a wider variety of tasks.
6. Among these are study tours to other countries. This cross-training is a form of 'learning-by-observing' in other countries, an implicit knowledge acquisition process that is different from explicit training on how to do things. It involves twinning or seconding, which pair together institutions in a horizontal knowledge exchange process (Stiglitz, 1999).
7. For example, a 28.8 kbps modem on a home computer may yield a transmission speed of no more than 24.6, a speed loss of 14.5 per cent because of the quality of telephone lines.
8. See Oyelaran-Oyeyinka and Lal, K., 'Internet Diffusion in Sub-Saharan Africa: a cross-country study', *Telecommunication Policy*, 29 (2005) 507–527.
9. It may be mentioned that no public domain, privately owned databases, or government surveys provide data on employment in India.
10. According to Ministry of Industry Survey 2002, 95.02 per cent of small scale industries (SSIs) are proprietary.
11. Managing directors and owners are used interchangeably henceforth.
12. According to Goldin and Katz (1998, p. 704) ' The increased reliance on electricity as a source of horse-power and the introduction of unit-drive appears to have had effects similar to the movement of continuous-process

methods.... The role played by skilled labor in machine-maintenance means that capital and skilled labor are relative complements within any given manufacturing production process'.

13. Siegel et al. (1997) suggest that three types of skill empowerment may result when advanced manufacturing technologies are adopted: (a) training, (b) changing employees' job responsibilities, and (c) creating new jobs and career opportunities for employees.
14. See Smith, K. 'Economic Infrastructure and Innovation Systems', in Edquist and Johnson (1992).
15. With the introduction of mobile telephony, the teledensity situation has changed dramatically in the two African countries. In less than three years, Nigeria has registered about five million mobile subscribers.
16. It may be mentioned that no public domain, privately owned databases or government surveys provide data on employment in India.
17. The Capitaline database is maintained and distributed by M/s Capital Market Pvt. Ltd. The dataset contains information of about 8000 firms and 300 variables. These firms are listed on all major stock exchanges in India.
18. SAP, a German multinational, is one of the top e-business solutions providing company in the world.
19. A study by Muller-Falcke (2001) finds that small firms in India were using ICTs in peripheral activities.
20. E-mail and internet were launched by videsh sanchar nigam limited (VSNL),for public on 15 August 1995. which was then a public sector company, VSNL is now a private firm owned by the Tata group, a leading industrial house in India.
21. This chapter is based on a paper published in *World Development* in 2004. However, we have used a larger firm sample than used in the original study. The results differ with regard to firm profit margins and skill intensity. Emergence of profit margins as a significant determinant of export performance suggests that export-oriented firms have attained maturity in using e-business technologies. Consequently, they have been able to earn higher profit margins along with reaping other benefits of ICTs.

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