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A UK Test of an Inflation-Adjusted Ohlson Model

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Abstract: This paper conducts a UK test of a version of the Ohlson (1995) model. We should only expect abnormal earnings to revert to zero if the book value of assets is economically meaningful. In this paper we make use of the property revaluations common in UK accounts, but estimate other asset values and earnings in inflation-adjusted terms. This, we argue, gives rise to estimates of abnormal earnings that can reasonably be expected to revert to zero. We then test this modified model on UK data using the Dechow, Hutton and Sloan (1999) method. In line with the predictions of the Ohlson model, we find that these modified abnormal earnings appear to mean revert, and that a first order autoregressive process is sufficient to capture the persistence of UK real abnormal earnings. The modified abnormal earnings model in general predicts one year ahead earnings more successfully than an unmodified model. Furthermore, for much of the sample period, one year ahead predictions of abnormal earnings are better for the real model during periods of higher inflation. The undervaluation problem found in prior studies appears to be replaced with an overvaluation problem in the real model which is more acute during periods of high inflation. Last, we show that an estimate of the model based upon an industry level specification appears to perform no better than a market-wide specification of the model.

Keywords: Ohlson model, inflation, UK test

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1. INTRODUCTION

Over the past two decades, considerable attention has been paid to the relationship between accounting numbers and firm value. An important contribution in this regard was Peasnell (1982) which rigorously set out the earlier established principle that the theoretical value of the firm was equal to the present value of its residual income stream plus the opening book value of its assets. This attention to the relationship between theoretical firm value and the residual income stream has attracted considerable practitioner interest and resulted in a number of proprietary models being marketed (the best known example perhaps being the Economic Value Added or EVA® model of Stern Stewart). The Ohlson (1995) model is a special case of the general class of residual income model (RIM) described in Peasnell (1982). The Ohlson (1995) and Feltham and Ohlson (1995) residual income valuation models are seen as a major breakthrough (Bernard, 1995). Lundholm (1995) states that 'The Ohlson (1995) and Feltham and Ohlson (1995) papers are landmark works in financial accounting'. The particular innovation in the Ohlson model is the employment of a 'linear information dynamic' whereby abnormal earnings and an 'other information' parameter follow an autoregressive process to revert to a mean of zero, provided the autoregressive parameter does not take on the theoretical maximum value of 1.0. This imposition of a particular evolution of abnormal earnings is superficially attractive for analytic purposes, but raises the central question of why, in general, abnormal earnings should be expected to revert to zero.

Barker (2001, Ch.9) discusses this issue, but economic theory suggests abnormal earnings will only revert to zero if book value is related to economic value. It seems clear that in an economy with large differences in the annual rate of inflation, and sometimes a long asset replacement cycle, historical book values will not be economically meaningful. At the same time, attempts to revalue some assets (notably property assets) violate the clean surplus assumption required by any general RIM, although this is not necessarily a problem (see Stark, 1997). Our objective here is to specify a version of the Ohlson model that is in line with the suggestion proposed by Walker (1997, p. 354) that historical cost accounting versions of the model be abandoned in favour of one based upon deprival values. To some degree, UK accounting during the period under investigation used partial deprival values with a particular form of 'dirty surplus' accounting. This particular form was the revaluation of property assets and the crediting of that revaluation direct to a reserve account. We attempt to make all fixed asset values consistent by revaluing all fixed assets to a comparable inflation-adjusted basis, which subject to further assumptions can be viewed as a proxy for the current value of these assets. Under conditions where asset values represent current 'values to the business', economically meaningful accounting rates of return can be derived (Edwards, Kay and Mayer, 1987) and competitive pressures should reduce abnormal returns to zero. One caveat here is that some intangible assets, most notably 'knowledge assets', are not generally included in book values and so some persistence in abnormal earnings may be expected. For this reason, in our empirical tests of the revised Ohlson model, we also estimate individual industry parameters, the argument being that the importance of intangibles is likely to be greater in some industries (e.g. the pharmaceuticals and information technology sectors) than others.

Having set out our revised model, we go on to test this model and compare these results with tests based on the standard version of the model, which simply ignores the issue of inconsistent inflation adjustments and associated 'clean surplus' violations inherent in UK accounting practices. Our empirical tests of the models follow the recent tests of Dechow, Hutton and Sloan (1999, hereafter DHS). For the reasons explained above, we also test the revised model at the industry level. Our tests examine whether or not abnormal earnings are mean-reverting, and whether contemporaneous stock prices are explained by the model. Broadly, our conclusions can be summarised as showing that the earnings persistence parameter and the 'other information' persistence parameter behave in a manner consistent with the predictions of the Ohlson model. Furthermore, the inflation-adjusted version of the model appears to predict earnings one period ahead more successfully than does the standard model. Finally, the industry-level version of the revised model suggests that there are considerable inter-industry variations between the behaviours of both persistence parameters.

The paper now proceeds as follows. Section 2 reviews the relevant literature on the Ohlson model and empirical tests of that model; Section 3 describes the modification of the Ohlson model used in this study; Section 4 describes the data and method employed; Section 5 presents the results; and Section 6 concludes.

2. LITERATURE REVIEW

The Ohlson (1995) model assumes that, in a competitive economy, abnormal earnings (that is earnings less the cost of capital multiplied by the opening book value of the assets), x_t^a, are likely to be temporary. If a company can indeed achieve a rate of return in excess of its cost of capital, giving rise to abnormal earnings, then these earnings are unlikely to persist in the long term. The relationship between abnormal earnings in successive years is described by a persistence parameter, ω, in Ohlson (1995) so that $x_{t+1}^a = \omega x_t^a$. The model further incorporates an 'other information' parameter into the earnings prediction process which is also assumed to revert to zero. These zero-mean reverting properties are described by Ohlson as being the 'linear information dynamic' model (LID) and can be described as:

$$x_{t+1}^a = \omega x_t^a + \nu_t + e_{1,t+1} \tag{1}$$

$$\nu_{t+1} = \gamma \nu_t + e_{2,t+1}. \tag{2}$$

Where 'abnormal' earnings or residual income is given by $x_t^a = x_t - r_{et}.b_{t-1}, b_{t-1}$ is the lagged or opening book value of equity, r_{et} is the cost of equity capital, ω and γ are the persistence parameters which are assumed to take on a value between 0 and 1, and ν_t is value-relevant information other than abnormal earnings. The model assumes that ν_t is unrelated to current earnings and dividends (Walker, 1997). The other information variable in the Ohlson (1995) model formalises the idea that

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[1] Walker (1997) illustrates that the random walk model of earnings is a special case of this model in which ω equals one, all earnings are distributed to investors, and where γ and the variance of e_2 both equal zero.

prices reflect a richer information set than transaction-based, historical-cost earnings (Beaver, 2002). e_1 and e_2 are normally distributed with a mean of zero.

Walker (1997) demonstrates that the linear information dynamics (LID) model introduces two new ideas.

> *The first is the notion of information that is observed by the market before it affects reported earnings. This is captured by the term ν_t that is observed in period t but does not affect earnings until $t+1$. The second is the notion that abnormal earnings may converge to zero over time.*

This in turn implies that book values and market values will converge. However, Barker (2001) asserts that abnormal earnings will not revert to zero unless book value is economically meaningful. Walker (1997, pp. 353–4) raises similar issues.

Ohlson's linear information dynamics also resolves the finite valuation problem inherent in most traditional valuation models (McCare and Nilsson, 2001). Further, it does not require explicit forecasts of future dividends (DHS). Combining linear information dynamics with the RIM yields a linear expression relating current equity market value to currently observable book equity, residual income, and 'other information', ν_t. That is:

$$P_t = b_t + \alpha_1 x_t^a + \alpha_2 \nu_t \tag{3}$$

where

$$\alpha_1 = \frac{\omega}{(1 + r_e - \omega)} \tag{3a}$$

$$\alpha_2 = \frac{(1 + r_e)}{(1 + r_e - \omega)(1 + r_e - \gamma)}. \tag{3b}$$

Walker (1997) summarises the advantages of the Ohlson approach in the following points:

(i) The Ohlson model refocuses our attention towards fundamental valuation issues and revives interest in models that attempt to explain firm valuation directly rather than correlating earnings surprises with returns.
(ii) The impact of retained earnings on future earnings is considered as a result of this approach.

(iii) The clean surplus approach has helped to provide a more coherent theoretical framework for traditional market-based studies.
(iv) The approach has, through the clean surplus relation, led to a renewed focus on profitability analysis as a framework for the fundamental valuation of equities. He illustrates that there are two reasons why predictable abnormal profits can occur: (a) predictable errors due to conservative (aggressive) accounting practices; or (b) predictable future abnormal economic profit arising from current or future investments.

As Walker (1997, p. 354) notes, the work of Edwards, Kay and Mayer (1997) suggests that accounting returns based upon deprival values 'should quickly converge to the costs of capital' in competitive markets. This motivates the adaptation of the model which follows. We should note that there are several drawbacks associated with the Ohlson model. Firstly, book value and abnormal earnings are not independent of one another, but are instead affected jointly by a company's accounting methods (Barker, 2001).

Secondly, empirical tests of the model show that it tends to underestimate contemporaneous stock prices (e.g. DHS). Moreover, some aspects of the model are not supported by the empirical data (e.g. Myers, 1999; Barth, Beaver, Hand and Landsman, 1999; Joos, 2000; and DHS), such as the linearity properties and the consistency among the coefficients in the system of linear information dynamics and valuation equations (Beaver, 2002). For example, while the Ohlson (1995) model assumes that the persistence parameter, ω, follows an autoregressive process with one lag, DHS find that the second lag is statistically significant ($t = 7.50$). Moreover, Bar-Yosef, Callen and Livnat (1996) reject the one-period lagged linear dynamic. Lastly, all of the studies that implement the Ohlson (1995) model yield negative abnormal earnings, on average (e.g. DHS; McCare and Nilsson, 2001, among others).

To date, no published study exists that tests the Ohlson (1995) model using UK data. However, in the US a number of studies have shed light on the empirical implications of the linear information dynamics (LID). Bar-Yosef, Callen and Livnat (1996) investigate the information dynamics of the Ohlson (1995) model. Specifically, they investigate the potential relevance of earnings, the book value of equity, and dividends for firm valuation based on the Ohlson (1995) model. They reject the one-period lagged linear dynamic for a large sample of firms during the period of 1960 to 1987. They find that earnings, book values of equity and dividends are valuation relevant for multi-period information dynamics. Another four studies that attempt to test Ohlson's (1995) linear information dynamics are Myers (1999) Hand and Landsman (1998 and 1999) and DHS. All these studies find evidence inconsistent with the linear information dynamics. For example, DHS find that the inclusion of three additional lags of abnormal earnings increases the explanatory power from an R-squared of 0.34 to one of 0.35. Myers (1999) examines four different specifications for the linear information dynamics model. He finds that these specifications under-perform book value alone in estimating equity values. Hand and Landsman (1999) find evidence that dividends are positively priced, inconsistent with the negative relation predicted by dividend displacement in the Ohlson (1995) model.

In an attempt to test the predictive ability of the Ohlson (1995) model, DHS argue that previous empirical applications of the model fail to incorporate information dynamics. They rely on Ohlson's (1998) suggestion, using analyst earnings forecasts to proxy non-accounting information. They find that the analysts' forecasts of abnormal earnings are much more accurate than the forecasts generated by the historical time-series models. Moreover, they report a negative bias of about 26 per cent in their estimation relative to current market value.

McCare and Nilsson (2001) investigate two approaches to implement Ohlson's (1995) model: the residual income valuation model (RIM) and the linear information dynamics model (LID). They find that the value of the autoregressive coefficient, ω, for Swedish firms of 0.523 is lower than DHS's value of 0.62 using US data. A first order approximation appears to capture the majority of the persistence of residual income in Swedish firms. Moreover, they find that using consensus analysts' median return on equity forecasts instead of current ROE results in a significant increase in cross-sectional correlation between fundamental values estimated from the basic RIM model and current stock prices. Finally, they sorted the stocks each year into five portfolios based on the value to price (V/P) ratio for each specification. They find that the model that used the analysts' forecasts is the only model that is statistically significant (hedge return = 0.099 and *t*-statistic = 4.09).

Some recent research has focused on trying to improve the predictive ability of the LID model. Choi, O'Hanlon and Pope (2003) investigate DHS's (1999) results to explore one potential explanation for the bias in LID-based value estimates. They assume that book value grows at a constant rate. To justify their assumption, they modify the Ohlson (1995) LID to include intercept parameters for abnormal earnings and other information.[2] Compared with DHS's (1999) results, Choi, O'Hanlon and Pope (2003) find that using the modified version of the Ohlson (1995) LID produces a less biased value for a range of cost of capital and growth assumptions.

3. THE INFLATION-ADJUSTED VERSION OF THE OHLSON (1995) MODEL

As we note above, economic theory suggests abnormal earnings will only revert to zero if book value is related to economic value. It seems clear that in an economy with large differences in the annual rate of inflation, and comparatively long asset replacement cycles, historical book values will not be economically meaningful. At the same time, attempts to revalue some assets (notably property assets) violate the clean surplus assumption required by a general RIM, although the analysis of Stark (1997) would suggest that this violation is not in itself problematic. Our objective here is to specify a version of the Ohlson model that could reasonably be expected to hold in competitive environments because the book values used are approximations of deprival values. As a side issue, to a degree our reformulation helps deal with a particular aspect of 'dirty surplus' accounting

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[2] They define abnormal earning as: ${X^a}_{t+1} = \omega_0 + \omega_1 {X^a}_t + \nu_t + e_{1,t+1}$; $V_{t+1} = \gamma_0 + \gamma_1 \nu_t + e_{2,\ \mathrm{t+1}}$; $BV_{t+1} = BV_t.G + \mathrm{e}_{3,\ \mathrm{t+1}}$. Where, G is one plus the rate of growth in book value. All variables are scaled by the book value of equity.

prevalent in the UK over the past three decades, subject to certain assumptions. This aspect was the revaluation of property assets and the crediting of that revaluation direct to a reserve account, which is problematic for any attempt to test the Ohlson model on long run UK data without detailed knowledge of individual firm level reserve transactions.

O'Hanlon and Peasnell (2004) show that in general, there is no particular need to formulate residual income models in 'real' terms. Both nominal and inflation-adjusted models produce identical valuations. However, our focus here is with the properties of the Ohlson model, and with time varying inflation, empirically derived estimates of the coefficients in the Ohlson model will differ. To give one example, a firm may earn zero abnormal earnings if book values are expressed on a deprival value basis. In this situation, if inflation is constant, nominal abnormal earnings will be positive, and will grow at the inflation rate, so that the omega coefficient will be one plus the inflation rate. If inflation is not constant, but the rate of inflation is slowing (which was the general feature of the UK experience during our sample period) nominal cost of capital estimates will reflect *expected* inflation, whereas balance sheet values reflect *historical* inflation leading to a more complex problem in interpreting historical cost omega values. The important issue here is that the omega coefficient in the Ohlson model may be more reliably estimated in real terms than in nominal terms. Notwithstanding the fact that the valuation of the firm must be equivalent if the future series of residual income figures is correctly estimated, it may be that more reliable estimates of these series are obtained in real terms rather than nominal terms. In the UK, the practice of revaluing property assets further clouds the reliability of historical cost-based estimates.

A further implementation issue that arises is discussed in Choi et al. (2003). Those authors point out the problems implicit in ignoring the intercept terms in a DHS-style implementation of the Ohlson model. They make use of the Feltham and Ohlson (1995) framework with intercept terms, a device that is in part motivated by a concern over the significant intercept coefficients reported in empirical tests of the Ohlson model and the suggestion that this is caused by accounting conservatism. Our approach is in the same spirit, though rather than attempting to incorporate accounting conservatism into the model by using the (arguably more general) Feltham and Ohlson (1995) framework, in our revaluation model we choose to tackle one of the causes of accounting conservatism in the UK. One criterion for judging the success of our model is whether or not the intercept terms for future residual income on past residual income are insignificantly different from zero.

We start with the Peasnell (1982, p. 362) expression (1), and the usual clean surplus assumption. That is:

$$P_0 = \sum_{t=1}^{t=N} V_t d_t + V_N TV_N. \tag{4}$$

Where TV_N is the terminal value of the firm at time N, d_t is the dividend in year t, and V_t is a valuation function given by:

$$V_t = \frac{1}{\prod_{t=1}^{t=T} (1 + r_{et})} \tag{4a}$$

and r_{et} is the appropriate cost of capital in year t, and earnings, x_t, are given by:

$$x_t = d_t + b_t - b_{t-1}. \tag{4b}$$

Under such circumstances Peasnell (1982) demonstrates that a completely general result for any class of valuation principles (provided clean surplus accounting applies) is:

$$P_t = \sum_{\tau=t+1}^{\tau=N} V_\tau x_\tau^a + V_N TV_N. \tag{5}$$

Abnormal earnings can equivalently be expressed by:

$$x_t^a = b_t - b_{t-1} + d_t - r_{et}.b_{t-1} = b_t - (1 + r_{et})b_{t-1} + d_t. \tag{6}$$

Re-arranging to express this in terms of the dividend we have:

$$d_t = (1 + r_{et})b_{t-1} + x_t^a - b_t. \tag{7}$$

Now define an inflation index (base year 0) for year t:

$$I_t = \prod_{s=0}^{t} (1 + i_s) \tag{8}$$

and a real (in year 0 price levels) equivalent of the dividend series given by d_t^0 where the real dividend is defined as:

$$d_t^0 = d_t / I_t. \tag{9}$$

Now assume that there is a constant real cost of capital, r_e', so that a real terms valuation function can be defined as:

$$V_t^0 = \frac{V_t}{I_t}. \tag{10}$$

The valuation model can now be expressed in real terms as:

$$P_0 = \sum_{t=1}^{t=N} V_t^0.d_t^0 + V_N^0 TV_N^0. \tag{11}$$

Further define A_t as the book value of assets at time t, D_t as the book value of debt at time t, so that $b_t = A_t - D_t$, a_t as the investment in tangible and intangible net assets and m_t as the investment in monetary net assets (for simplicity we assume that the working capital cycle is zero days)[3] during year t, so that $A_t = A_{t-1}/(1+\delta_t) + a_t + m_t$, where δ_t is the rate of depreciation at the end of year t.[4] Define debt interest as r_{dt}. Cash flow, c_t, is defined so that:

$$x_t = c_t - \left[1 - \frac{1}{(1+\delta_t)}\right] A_{t-1} - r_{dt}.D_{t-1}.$$

The accounting identity implies that:

$$d_t = c_t - a_t - m_t - r_{dt}.D_{t-1} + D_t - D_{t-1},$$

hence:

$$\begin{aligned} A_t &= A_{t-1} - \left(1 - \frac{1}{1+\delta_t}\right).A_{t-1} - D_t + a_t + m_t \\ &= \frac{A_{t-1}}{1+\delta_t} + a_t + m_t - D_t. \end{aligned} \tag{12}$$

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[3] Changing this assumption simply requires a revaluation expression for stocks of raw materials and work in progress.

[4] Note that in keeping with the usual assumptions of discrete time discounted cash flow models all cash flows and value changes are assumed to occur at the year end.

We now wish to define an approximation of the current replacement book value of assets, A'_t and a current replacement cost depreciation charge. We assume that asset prices increase in line with the general rate of inflation and that the rate of technological innovation is given by θ_t. Assuming the firm commenced business in year zero, as Lindenberg and Ross (1981), show the recursive relation of replacement cost of assets will be given by:

$$A'_t - m_t = \left(A'_{t-1} - m_{t-1}\right)\left(\frac{[1+i_t]}{[1+\delta_t][1+\theta_t]}\right) + a_t. \tag{13}$$

Continuing the recursion we have:

$$A'_t - m_t = \sum_{\tau=0}^{t}\prod_{s=\tau}^{t}\left(\frac{[1+i_s]}{[1+\delta_s][1+\theta_s]}\right)a_\tau. \tag{14}$$

Note we assume that the *rate* of depreciation on current cost asset values is identical to the rate of depreciation on historical book values. The historical book value of the fixed assets is simply:

$$A_t - m_t = \sum_{\tau=0}^{t}\prod_{s=\tau}^{t}\left(\frac{1}{1+\delta_s}\right)a_\tau. \tag{15}$$

So that difference between historical book values and nominal book values, or cumulative holding gain, is defined as:

$$A'_t - A_t = \sum_{\tau=0}^{t}\prod_{s=\tau}^{t}\left(\frac{1}{1+\delta_s}\right)\left[\frac{\prod\limits_{s=\tau}^{t}(1+i_s)}{\prod\limits_{s=\tau}^{t}(1+\theta_s)} - -1\right]a_\tau. \tag{16}$$

Following Edwards and Bell (1961) we can partition nominal earnings in any one year into holding gains on assets, debt and real earnings. Assume that asset prices increase in line with general inflation, that net monetary assets (excluding debt), m_t, are zero (or, equivalently, that the overall average price increase on assets is the rate of inflation), and that the rate of technological improvement is zero.[5] Re-defining book values in terms of current price

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[5] These simplifying assumptions merely avoid real holding gains or losses occurring on assets. If real holding gains or losses occur they are simply recognised as real income in what follows, which is a variation on Peasnell (1982, p. 362).

levels, we have holding gains, h_t, given by $h_t = b'_{t-1}.i_t$. By assumption there are no real holding gains on assets, so these are simply inflation related 'gains'. As in O'Hanlon and Peasnell (2004) these 'gains' can be decomposed into the inflation-related gain on debt, $h_t^d = D_{t-1}.i_t$, and the 'gain' on assets, $h_t^a = A_{t-1}.i_t$. As they note, the inflation-related gain on assets is 'fictional'. However, the inflation-related gain on debt is not, but merely serves to offset the increased (nominal) interest charge lenders require to offset the decreased purchasing power of the principal.[6] The effect of adjusting for this inflation gain on debt is identical (ignoring tax effects) to replacing the nominal interest charge in the profit and loss statement with an equivalent real interest charge.

Current cost earnings expressed in end year *t* price levels can then be defined as:

$$x_t^{ct} = x_t - h_t^a = b'_t - (1 + i_t)b'_{t-1} + i_t.D_{t-1} + d_t. \tag{17}$$

So current cost abnormal earnings in year *t* can now be defined as:

$$x_t^{act} = b'_t - (1 + r'_e)(1 + i_t)b'_{t-1} + i_t.D_{t-1} + d_t. \tag{18}$$

However, since $-(1 + r')(1 + i_t) = -(1 + r)$, current cost abnormal earnings in terms of year *t* price levels are identical to nominal abnormal earnings based upon current book values.[7] Earnings thus defined are those O'Hanlon and Peasnell (2004) refer to as being on a 'nominal current cost basis'. Critically, since we are interested in the transition of real abnormal earnings net of inflation effects, in our tests, we re-base all our values to a common year price level, which is equivalent to the O'Hanlon and Peasnell (2004) 'real current cost residual income in real terms' definition of RI, given our assumption of no real holding gains on assets. To re-base to common price levels involves dividing abnormal earnings and book values through by the price index, so to render the abnormal earnings expression in year 0 price levels, we divide through by (8), which yields $x_t^{ac0} = x_t^{act}/I_t$ and $b_t^0 = b'_t/I_t$. In general, for brevity we henceforth refer to this constant-prices version of current cost abnormal earnings as 'real' abnormal earnings.

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[6] Throughout, we assume that inflation is anticipated.

[7] We are grateful to the referee for making this distinction.

Making the usual assumption for residual income and dividend discount models, that the present value of the book assets in year N will be approximately zero, enables the final term to be dropped, which then leaves the valuation function (in terms of price at year 0 levels):

$$P_t^0 = b_t^0 + \sum_{\tau=1}^{\infty} \frac{x_{t+\tau}^{ac0}}{\left(1 + r_e'\right)^{\tau}}. \tag{19}$$

Of course, properly implemented a property of residual income models is that *any* choice of accounting system which satisfies the clean surplus condition will result in a book value and residual income series that yields a theoretical price identical to that given by (19). However, our interest here is on the *pattern* followed by the residual income series, and the evolution of this will vary according to the accounting system chosen. The particular contribution of Ohlson was to assume a particular process of 'information dynamics' that places a restriction on the dividend/abnormal earnings discount model. All we do here is to follow the spirit of Ohlson but assume that the real abnormal earnings (or, equivalently, *nominal current value abnormal earnings*)[8] follow an autoregressive process of the following type:

$$x_{t+1}^{art} = \omega x_t^{art} + \nu_t + \varepsilon_{1,t+1} \tag{19a}$$

$$\nu_{t+1} = \gamma \nu_t + \varepsilon_{2,t+1}. \tag{19b}$$

As in the Ohlson model ω is assumed to have a value between zero and 1.0.

The particular focus here is on the nature of h_t within the UK accounting system. Here we partition assets into three categories: property assets, p, other fixed assets, f, and net working capital, w, such that $b_t = p_t + f_t + w_t - D_t$. We observe that UK firms have historically revalued property assets regularly,[9] but that the holding gain is taken directly to reserves in contra-

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[8] A term we are grateful to the referee for suggesting.

[9] For example, Samuels, Brayshaw and Craner (1995, p. 144) note that British companies generally value property on an open market value for existing use basis, and that in the UK most revaluations undertaken relate to property assets. See also Aboody, Barth and Kasznik (1999).

vention of clean surplus accounting principles. We make the simplifying assumption that property prices increase in line with general inflation, that no other assets are revalued using 'dirty surplus' accounting, and that the working capital holding period is not significantly different from zero days. It then follows that property assets (by virtue of dirty surplus revaluation in line with inflation) and current assets (by assumption) are already valued at current value to the business, but that other fixed assets need to be revalued to reflect the change in price levels. In other words, the adjustments required by (14) and (16) above do not need to be applied to all book assets, but merely to non-property and non-working capital assets.

In this paper, we do not apply the full Lindenberg and Ross (1981) algorithm given in (16), because to do so requires a very long run of historical asset purchase data. Lindenberg and Ross are able to obtain accounting data going back to 1952 for their sample of US firms. Such a long run of data is not available for our sample of UK firms, so we use an approximation of asset uplift used in the estimation of IRRs (or Cash Flow Return on Investment [CFROI]) in valuation models such as that described in Madden (1996) and Gregory (2002). This involves estimating the gross book value of the non-property and non-working capital assets at current prices by uplifting the opening gross book value of these assets by $(1 + \text{inflation rate})^{\text{age}}$. Here *age* is the average asset age approximated from dividing the accumulated depreciation figure for these assets by the depreciation charged during the year. Revised depreciation charges are then based upon this value uplift. The inflation rate employed is the geometric average inflation rate, as measured by the retail price index, that applied over the calculated average age of the assets. The adjusted *net* book value of the assets cannot be estimated using the average age, as this ignores the fact that the older assets will have a greater proportion of their value written down. Provided asset purchases are approximately constant (in real terms), a reasonable approximation of the uplift can be obtained by uplifting the closing NBV by $(1 + \text{inflation rate})^{\text{age}/2}$. The reasonableness of this approximation will be a function of the periodic inflation rates observed over the calculated life, and the rate of real growth in the asset base (see Madden, 1999, pp. 114–18 and 253–54). In order to check the scale of error likely to be encountered in such an approximation, we carried out some simulations for a firm that has a constant rate of replacement of a portfolio of assets with five and ten year lives through the period of our study, but with assets invested growing each year at the annual GDP growth rate. On the assumption the firm used straight line depreciation and that the rate of asset price inflation was identical to the general inflation rate, we then calculated true current cost accounting (replacement cost) asset values and depreciation charges and compared these to the values that would result from our approximation at various points in time chosen to reflect changes in the experienced rate of inflation. Despite the relative crudeness of the adjustment, errors were small (typically around 1–2%). Given that UK accounting is not clean surplus, we do not apply (17) above, but rather we estimate current cost earnings as historical cost earnings, less the depreciation adjustment, plus the holding gain on debt. Given we assume no *real* holding gains on assets, this is computationally equivalent to equation (17) in O'Hanlon and Peasnell (2004).

4. DATA AND RESEARCH METHOD

All non-financial UK firms (whether dead and alive) with available data for the period 1976–2000 are used in this study.[10] The empirical analysis of this study uses both accounting and financial market information. We collect data from two sources. First, we use the DataStream financial database (hereafter, DS) to collect annual accounting data on earnings, book values of equity, book values of debt, market values of equity, depreciation, and fixed assets as well as accumulated depreciation. Fixed assets and accumulated depreciation include plant and machinery and other fixed assets. Second, we use the London Share Price Database (hereafter, LSPD) to collect data on monthly returns and annual market capitalisation. The companies are

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[10] Financial firms, property, and investment trusts are excluded from the sample. This type of exclusion is common in the literature. For example, Rees (1997) argues that this is conventional as the relationship between value and accounting numbers is thought to be very different for financial firms compared to industrial and other non-financial firms.

matched between the two sources by their SEDOL number. Inclusion of firms in the sample required satisfying the following criteria. First, annual data on book value of equity, earnings, market value of equity, depreciation, and fixed assets have to be available in the DS database. Second, monthly returns have to be available. Following Frankel and Lee (1998), among others, we exclude firms with negative book value since abnormal earnings based upon negative book values have no obvious economic interpretation.

Our empirical analysis requires a measure of the discount rate and the inflation rate. The latter has been collected from the *International Finance Statistics* book (yearbook 1987 and 2001) covering the period 1959 to 2000. We use the Retail Price Index, hereafter RPI, as a proxy to measure inflation rate as $(\mathrm{RPI}_t - \mathrm{RPI}_{t-1})/\mathrm{RPI}_{t-1}$. For the former, we use a constant 5%. In order to allow a direct comparison of our results with those of previous researchers, we also present results using an unmodified Ohlson model and unadjusted accounting data. For this 'historical accounting' analysis, we argue that it is unreasonable to assume a constant nominal cost of capital given the vast variation in inflation rates over the period of our study, and so chose a cost of capital based upon the medium term gilt yield in January of year *t* with a 4.6% risk premium added. Further tests showed that our general conclusions with regard to the Ohlson model parameters are robust to variations in this cost of capital assumption. To illustrate this, we also present results for the modelling of the autoregressive properties of abnormal earnings using a 3.0% risk premium in the historical accounting analysis.

(i) Model Specifications

Formally, we test the following hypotheses for both the 'historical' and 'real' models: 1. that abnormal earnings and 'other information' mean-revert; 2. that the intercept terms in (28) and (29) below are zero; 3. that one year ahead abnormal earnings are predicted by the model; and 4. that contemporaneous stock prices are explained by the model. As in DHS, we start by testing whether earnings and 'other information' exhibit the mean-reverting behaviour predicted by the Ohlson model.

Specifically, we test whether an autoregressive process with a single period lag captures the behaviour of these variables for either the unmodified 'historical' model or our revised inflation-adjusted earnings model, hereafter referred to as the 'real' model. Following DHS (1999) we then test the information value of LID, by estimating three specifications based on the Ohlson (1995) model. The first specification omits the 'other information' variable, v, and assumes the immediate reversion of residual income to a zero mean, that is:

$$P_t = BV_t. \tag{20}$$

This specification assumes that all value-relevant information is reflected in the current book value of equity, that is, expectations of future abnormal earnings are based on information in current abnormal earnings and that abnormal earnings are purely transitory. Thus, equity market value is represented by the current book value of equity.[11]

The second specification includes the mean reversion in residual income, w, that is:

$$P_t = BV_t + \alpha_t X_t^a. \tag{21}$$

This specification assumes that all value-relevant information is reflected in current and historical financial statements, that is, expectations of future abnormal earnings are based on current abnormal earnings, and that abnormal earnings mean revert at their unconditional historical rate. Thus, the relative weight on book value is decreasing in the persistence parameter, while the relative weight on abnormal earnings is increasing in the persistence parameter (DHS).

The third specification includes other information as well as residual income, that is:

$$P_t = BV_t + \alpha_1 X_t^a + \alpha_2 \nu_t. \tag{22}$$

This specification includes value-relevant information from non-accounting sources, ν_t. Thus, this model represents the residual income valuation model proposed by Ohlson (1995). The model implies that book value, current abnormal earnings

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[11] This specification assumes that w equals zero.

and the other information embedded in the forecast of next period's abnormal earnings all contain incremental information about price (DHS, 1999).

The empirical implementation of the LID model and the valuation functions in equations (20) to (22) require three variables (book value of equity, earnings, and other information, BV_t, X_t, and ν_t respectively) and the estimation of two parameters (the persistence parameter of abnormal earnings, ω and the persistence parameter of the other information variable, γ).

Following DHS and as suggested by Ohlson (1998), we estimate the other information variable, ν_t as the difference between the market expectation of residual income for period $t+1$ based on all available information and the expectation of abnormal earnings based only on current period residual income, that is:

$$\nu_t = E\left[X^a_{t+1}\right] - \omega X^a_t. \tag{23}$$

DHS and McCare and Nilsson (2001), among others use the analyst consensus earnings forecasts (e.g. I/B/E/S)[12] as a proxy for the market's expectation of residual income in period $t+1$.

However, in this study we cannot use the analyst consensus-earnings forecasts as a proxy for the market's expectation of residual income in period $t+1$ since the consensus forecasts are not available before 1988 for UK data, whilst our sample covered the period 1976–2000. In addition, we note that prior research finds that analysts' earnings forecasts are systematically over-optimistic (e.g. Abarbanell, 1991; Stickel, 1990; DeBondt and Thaler, 1990; Bulkley and Harris, 1997; and Capstaff, Paudyal and Rees, 1995, amongst others).[13]

Capstaff, Paudyal and Rees (1995) investigate the accuracy and the rationality of earnings forecasts by UK analysts. In their

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[12] I/B/E/S refers to the Institutional Broker Estimate System.

[13] Also note that in Capstaff, Paudyal and Rees (1998b), Bhaskar and Morris (1984) provide evidence that analysts have the tendency to underestimate earnings. Further, O'Hanlon and Whiddett (1991) find that UK analysts have the tendency to underreact when revising earnings forecasts. Forbes and Skerratt (2001) confirm that, for the UK, overreaction in analysts' forecasts is clustered in small companies and at long forecast horizons. However, in large firms and at shorter horizons, they confirm the presence of under-valuation.

discussion, they illustrate that Arnold and Moizer (1984) find that the key factor in UK share appraisal methods is the predicted price-earnings ratio. Furthermore, Ou and Penman (1989) find that the E/P ratio is statistically significant in predicting earnings.[14] Capstaff, Paudyal and Rees (1995) use share prices as a composite indicator of the future earnings potential of the firm. They argue that share prices should capture all available information regarding future earnings. They use a forecast derived from the market-wide average earnings to price ratio as a test against the analysts' forecast accuracy. That is:

$$\text{Forecasted earnings} = f^{c}_{t+1} = \text{market}(\text{E}/\text{P}_t) \times \text{firm's } (\text{P}/\text{E}_t) \times \text{earnings}_t \,. \tag{24}$$

Where *market*(E/P$_t$) is the earnings-to-price ratio for the whole market.

Equation (24) assumes that the E/P ratio for the firm will move towards the E/P ratio for the market. Capstaff, Paudyal and Rees (1998a) explain that Lin, Pope, Ryan and Zarowin (1995) suggest that the E/P ratio is useful in forecasting earnings since it summarises in one number the history of price and earnings. In their review of prior research of earnings forecasting, Capstaff, Paudyal and Rees (1998b) demonstrate that forecast accuracy is conditional on the industry sector in which the firm operates, amongst other variables.[15] Therefore, we argue that using *industry* (E/P) instead of the *market* (E/P) will result in a better estimation. This implies that the firm's E/P ratio tends to move towards the E/P ratio for its industry. We use a finer partitioning of the industry price-earnings ratio because this will introduce more cross-sectional variation into the data and also because we expect the E/P ratio to reflect industry specific features.

Therefore, we use the following equation to estimate earnings forecast $\left(f^{c}_{t}\right)$, as a proxy for the market's expectation of residual income in period $t+1$.

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[14] Also note that, Lin, Pope, Ryan and Zarowin (1995) have asserted that E/P ratios have predictive value and can be used to improve analysts' forecasts.

[15] These variables are: firm size, the forecast horizon, and the time-effect as economic circumstances change.

$$E_t\left[X_{t+1}^a\right] = f_t^{ac} = f_t^c - r.BV_t. \tag{25}$$

Where f_t^{ac} is the forecasted abnormal earnings as above and forecast errors are based on Capstaff, Paudyal and Rees (1995) procedure, using the following equation:

$$f_{t+1}^c = \text{industry } (\mathrm{E/P}_t) \times \text{firm's}(\mathrm{P/E}_t) \times \text{earnings}_t. \tag{26}$$

Thus, the other information, ν_t can be measured as:

$$\nu_t = f_t^{ac} - \omega X_t^a. \tag{27}$$

To avoid any element of circularity in so far as price is used as one element in arriving at a measure of intrinsic value which is then compared to price in the results reported in Table 6 below, we use fiscal year end E/P ratios but compare Ohlson model predicted values to market values six months after the year end. The thinking here is to allow six months for markets to fully reflect information contained in earnings and book values, whilst the E/P ratio at the time of the year end ensures that prices cannot possibly reflect actual earnings, since no firm releases instantaneous earnings information.

Finally, Francis, Olsson and Oswald (2000) and Frank (2002), among others, argue that pooling the data over time overstates the significance level of a model. We use two alternative modelling approaches in order to estimate the persistence parameters, ω and γ. The first of these is a simple cross-sectional model and the second is a pooled cross-section regression model. Furthermore, for each of these two models, we estimate our persistence parameters using both historical data and real data as discussed above.

In the cross-sectional models, also referred to as the yearly analysis, the persistence parameter of abnormal earnings, ω, and the persistence parameter of other information variable, γ, are estimated over the period 1976 to 2000, that is:

$$X_{t+1}^a = \omega_0 + \omega_1 X_t^a + e_{t+1} \tag{28}$$

$$\nu_{t+1} = \gamma_0 + \gamma_1 v_t + e_{t+1}. \tag{29}$$

Mean coefficients for the intercept, slope coefficient and Fama-MacBeth *t*-statistics are then calculated. An additional specification of the abnormal earnings model is produced to examine the importance of a second lag in abnormal earnings using a simple AR(2) model. All variables are scaled by the market value of equity to control for heteroscedasticity (Beaver, 1999). Additionally, to reduce the effect of outliers, we drop any observations for which the residual is larger than three standard errors from the mean.

In the pooled cross-sectional models, also referred to as the pooled analysis, we estimate the persistence parameter of abnormal earnings, ω, and the persistence parameter of the other information variable, γ, for each year in the sample 1976–2000, with each regression using all available observations in the sample from the previous year (or two years in the AR(2) abnormal earnings model), thereby following the DHS methodology. Thus, we estimate equations (28) and (29) above in an expanding window pooled cross section approach working through the sample from 1976 until the year 2000. This is effectively a type of variable case panel regression, the benefits of this approach being that more information is contained than in the cross-sectional approach, giving more degrees of freedom and allowing more efficient estimation. All variables are scaled by the market value of equity at the beginning of year t, and we drop any observation for which the residual is larger than three standard errors from the mean. Coefficients for the intercept, slope coefficient and simple t-statistics are calculated, though only the results for the final (longest time-frame) pooled model are presented as this is estimated upon the entire sample and encompasses the data used in the other models.

5. RESULTS

(i) Autoregressive Properties of Abnormal Earnings:

Table 1 details the autoregressive properties of abnormal earnings. Panel A reports the results from a first-order abnormal earnings auto-regression, estimated on a cross-sectional (hereafter, *yearly analysis*) basis as well as on a pooled cross sectional basis (hereafter, *pooled analysis*). For the yearly model, the t-statistics are Fama-MacBeth t-statistics, whilst R-squared

Table 1

Autoregressive Properties of Abnormal Earnings

The autoregressive properties of abnormal earnings defined as:

$$X_{t+1}^{a} = \omega_0 + \omega_1 X_t^{a} + e_{i,t+1}$$

Model	ω_0	ω_1	*Mean of Dependent Variable*	*No. of Obs.*	*Adj-R^2*
Panel A: Historical Model – with One Lag (*r* = Gilt yield plus 0.046 as risk premium)					
Yearly analysis	−0.03	0.62	−0.068	991	0.49
	(−3.33)	(15.23)			
Pooled analysis	−0.02	0.57	−0.061	23750	0.48
	(−27.36)	(63.66)			
Panel B: Historical Model- with One Lag (*r* = Gilt yield plus 0.03 as risk premium)					
Yearly analysis	−0.02	0.59	−0.051	993	0.46
	(−2.61)	(15.40)			
Pooled analysis	−0.02	0.55	−0.045	23781	0.46
	(−21.51)	(60.94)			
Panel C: Real Model – with One Lag (*r* = 5% constant)					
Yearly analysis	−0.004	0.57	−0.003	927	0.45
	(−0.63)	(17.93)			
Pooled analysis	−0.001	0.55	−0.001	22211	0.52
	(−2.35)	(55.75)			

Notes:

The sample covered the period 1976–2000. The number of firms represents the average over the sample period in the case of yearly analysis, whilst it represents the total number of observations in the case of the pooled analysis. To reduce the influence of heteroscedasticity, all variables are scaled by the market value of equity at the end of the period. We drop any observation for which the residuals are larger than three standard errors from the mean, to reduce the effect of outliers. All *t*-statistics are in parentheses with standard errors calculated using White (1980) corrections.

coefficients are simple averages. Results are presented for 4.6 per cent and 3.0 per cent risk premia for the historical model, to illustrate the impact of a variation in the cost of capital, and for a 5 per cent constant cost of capital in the real model.

For the historical model, the higher risk premium produces values of the autoregressive coefficient, ω_1, equal to 0.62 and 0.57 for the yearly and pooled analyses, respectively, with *t*-statistics of 15.23 and 63.66. The lower risk premium produces values of the autoregressive coefficient, ω_1, equal to

0.59 and 0.55 for the yearly and pooled analyses, respectively, with *t*-statistics of 15.40 and 60.94. From these results, it appears that the mean reversion process for abnormal earnings of UK firms is very similar to that of US firms (e.g. the DHS, 1999, result is 0.62 with a *t*-statistic of 138.31, estimated using a pooled analysis). For Swedish firms, McCare and Nilsson (2001) report that the value of the autoregressive coefficient, ω_1, is 0.523 with a *t*-statistic of 23.025. However, our results indicate that the coefficient of determination is higher for the UK firms than that of the US firms (0.49 and 0.48 for the higher risk premium yearly and pooled analyses, respectively, and 0.46 for the lower risk premium yearly and pooled analyses, respectively) versus 0.34 for the US, estimated using a pooled analysis. Thus, as hypothesised in the Ohlson (1995) model, the persistence parameter of abnormal earnings, for UK data, falls between zero and one.

Consistent with DHS and McCare and Nilsson (2001), we report significantly negative intercepts (equal to −0.03 and −0.02 for the higher risk premium yearly and pooled analyses, respectively, and −0.02 and −0.02 for the lower risk premium analyses).[16] This implies that the average abnormal earnings are negative, which raises the issues addressed in Choi et al. (2003). Indeed, Panel A of Table 1 shows that the average abnormal earnings are −0.068 and −0.061 for the higher risk premium yearly and pooled analyses, respectively, with figures of −0.051 and −0.045 for the lower risk premium models. Prior research argues that the negative abnormal earnings results from the fact that the average estimated required rate of return is higher than the average return on equity (e.g. McCare and Nilsson, 2001; and Myers, 1999). However, an alternative argument is that there is a bias in the estimation of the historical residual income series since they have been calculated using reported earnings and book values of equity under UK GAAP rather than using a comprehensive income and capital provided by shareholders (Myers, 1999b), that is, the violation of the clean surplus assumption is a serious problem for any UK analysis.

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[16] Note that, Dechow, Hutton and Sloan (1999) report an intercept of −0.02 with a *t*-statistic of −29.04, whilst McCare and Nilsson (2001) report an intercept of −0.012 with a *t*-statistic of −3.384.

Panel C of Table 1 reports the values of the autoregressive coefficient, ω_1, for the real model, using a constant 5 per cent cost of capital. The values for the yearly and pooled analyses are equal to 0.57 and 0.55 with *t*-statistics of 17.93 and 55.75, respectively. The coefficient of determination is 0.45 and 0.52 for the yearly and pooled analyses, respectively. Thus, the value of the persistence parameter of abnormal earnings lies between the extreme values of zero and one as hypothesised in the Ohlson (1995) model. An interesting result for the real model is that, for the yearly and pooled analyses, the values of the intercept are far closer to zero, with an insignificant *t*-statistic for the yearly analysis and a marginally significant *t*-statistic for the pooled analysis. The Ohlson model predicts that the intercept term should be zero. Note also that the mean of the dependent abnormal earnings variable is much closer to zero in the case of the real model than the unadjusted historical model (−0.003 and −0.001 for the yearly and pooled real analyses respectively, compared to corresponding values of −0.068 and −0.061 for the higher risk premium historical model and −0.051 and −0.045 for the lower risk premium model).[17]

Thus, one contribution of the real model is that it significantly reduces the negative abnormal earnings problem that is inherent in all prior research that implements the Ohlson (1995) model. In common with DHS, we do not consider the implications of these intercept values in comparing intrinsic values with prices in Table 6 below, given the prediction of the Ohlson model that the intercept value should be zero. The negative intercepts imply either that cost of capital is set too high, or else that abnormal earnings have a persistent negative mean. The latter would in turn imply a lower intrinsic value. Clearly, employing a lower risk premium marginally improves the historical model as intercepts and mean dependents move closer to zero. However, we note that ignoring the negative intercept coefficients looks considerably more defensible in the case of the real model than in the case of the historical model.

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[17] Note that as these abnormal earnings have been scaled by market value of equity, it can be readily seen that a reduction in the equity risk premium to, say, 2.5% would still leave a substantial difference between the historical and real mean abnormal returns, suggesting that the clean surplus violations corrected for are of considerable importance.

The Ohlson (1995) model assumes that abnormal earnings follow an autoregressive process with a one-period-lag. DHS find that the second lag is statistically significant (t-statistic $= 7.50$), but they conclude that the first order autoregressive process appears to provide a reasonable empirical approximation of abnormal earnings for US firms. They argue that the magnitude of the second coefficient is too small to be of great importance (0.07 versus 0.59 for the first lag). McCare and Nilsson (2001) find that the second and third-period lag are not significant. Thus they conclude that for Swedish firms a first-order approximation captures most of the persistence of abnormal earnings. To investigate whether the first-order autoregressive process is sufficient to capture most of the persistence of abnormal earnings, we include a two-period lag of abnormal earnings in the model. Panel A of Table 2 reports the results for the historical model. The results indicate that the second-order coefficients for the two-period lag of abnormal earnings are 0.02 and −0.02 with t-statistics of 1.16 and −2.54 for the yearly and pooled analyses, respectively.

Thus, the coefficient is statistically significant in the case of the pooled analysis, while it is statistically insignificant in the case of the yearly analysis. The coefficient of determination increases from 0.48 to 0.50 in the case of the pooled analysis, whilst it remains a constant 0.49 in the case of the yearly analysis. Thus, the models are only marginally improved with the addition of a second lag in abnormal earnings. Indeed, the magnitude of the second order coefficients is very small. The intercepts from these models are a significant −0.03 for the yearly model and a significant −0.02 for the pooled model. Thus the historical model is only marginally improved by the introduction of an additional lag, but is still troubled by significant negative intercepts.

Panel B of Table 2 shows the second-lag of abnormal earnings for the real model. By contrast to the historical model, the values of the two year lag coefficients are 0.03 and 0.02 with marginally insignificant t-statistics of 1.95 and 1.96[18] for the yearly and pooled analyses, respectively. The adjusted R^2 stays constant at 0.45 in the case of the yearly analysis, whilst it

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[18] Rounded to two decimal places.

Table 2

Autoregressive Properties of Abnormal Earnings

The autoregressive properties of abnormal earnings defined as:

$$X^a_{t+1} = \omega_0 + \omega_1 X^a_t + \omega_2 X^a_{t-1} + e_{i,t+1}$$

Model	ω_0	ω_1	ω_2	*No. of Obs.*	*Adj-R^2*
Panel A: Historical Model – with Two lags					
Yearly analysis	−0.03	0.61	0.02	922	0.49
	(−3.47)	(11.93)	(1.16)		
Pooled analysis	−0.02	0.62	−0.02	21170	0.50
	(−27.86)	(53.99)	(−2.54)		
Panel B: Real Model – with Two Lags					
Yearly analysis	−0.007	0.544	0.03	858	0.45
	(−1.13)	(13.82)	(1.95)		
Pooled analysis	−0.003	0.54	0.02	19703	0.51
	(−5.03)	(44.9)	(1.96)		

Notes:
The sample covered the period 1976–2000. The number of firms represents the average over the sample period in the case of yearly analysis, whilst it represents the total number of observations in the case of the pooled analysis. To reduce the influence of heteroscedasticity, all variables are scaled by the market value of equity at the end of the period. We drop any observation for which the residuals are larger than three standard errors from the mean, to reduce the effect of outliers. All *t*-statistics are in parentheses with standard errors calculated using White (1980) corrections.

marginally declines from 0.52 to 0.51 in the case of the pooled analysis. So we see that a first order AR process is generally sufficient to capture the persistence of UK 'real' abnormal earnings in either the historical or real models, a result that is consistent with the Ohlson model properties.

(ii) Autoregressive Properties of the 'Other Information' Variable

Table 3 presents the values for the autoregressive coefficient of the 'other information' variable, ν_t. Panel A of Table 3 shows that the values of the autoregressive coefficients, γ_1, of the 'other information' variable for UK firms in the historical model are 0.56 and 0.65 and are significantly greater than zero with *t*-statistics of 21.28 and 80.86 for the yearly and pooled analyses, respectively. Further *t*-tests (not reported in the table) also show that the values of the coefficients are

Table 3

Autoregressive Properties of the 'Other Information' Variable

The autoregressive properties of other information defined as:

$$\nu_{t+1} = \gamma_o + \gamma_1 \nu_t + e_{i,t+1}$$

Model	γ_0	γ_1	*No. of Obs.*	*Adj-R^2*
Panel A: Historical Model – with One Lag				
Yearly analysis	−0.014	0.56	937	0.45
	(−3.87)	(21.28)		
Pooled analysis	−0.011	0.65	22363	0.59
	(−22.14)	(80.86)		
Panel B: Real Model – with One Lag				
Yearly analysis	0.001	0.580	929	0.43
	(0.37)	(13.08)		
Pooled analysis	−0.001	0.56	22146	0.48
	(−2.64)	(50.66)		

Notes:
The sample covered the period 1976–2000. The number of firms represents the average over the sample period in the case of yearly analysis, whilst it represents the total number of observations in the case of the pooled analysis. To reduce the influence of heteroscedasticity, all variables are scaled by the market value of equity at the end of the period. We drop any observation for which the residuals are larger than three standard errors from the mean, to reduce the effect of outliers. All *t*-statistics are in parentheses with standard errors calculated using White (1980) corrections.

significantly less than 1.0. The adjusted R^2 is 0.45 and 0.59 for the yearly and pooled analyses, respectively. In comparison with previous studies, the value of γ_1 for UK firms is higher than that for US and Swedish firms. For example, DHS report that the value of γ_1 is 0.32 with a *t*-statistic of 57.94 for US firms, while McCare and Nilsson (2001) report that the value of γ_1 is 0.436 with a *t*-statistic of 21.583 for Swedish firms. Moreover, for the US, the other information variable mean-reverts at about twice the rate of abnormal earnings ($\omega/\gamma = 0.62/0.32$). For Swedish firms, the corresponding figure is 1.2. McCare and Nilsson (2001) argue that this result means that the 'other value-relevant information seems to become obsolete faster in the US compared to Sweden'. Our result indicates that the values of ω/γ for UK data are 0.62/0.56 and 0.57/0.65 for the yearly and pooled analyses, respectively. Thus, for the UK, the other information variable mean-reverts at approximately the same rate of abnormal earnings in the case of the yearly analysis, whilst it mean reverts at a rate somewhat less than that of abnormal earnings in the case of the pooled analysis. Thus, value-relevant information for UK firms appears to have a longer 'shelf-life' than in the US or Sweden.

Panel B of Table 3 reports the value of the autoregressive coefficient, γ_1, for the 'other information' variable for the real model. The values are equal to 0.58 and 0.56 for the yearly and pooled analyses respectively, with t-statistics of 13.08 and 50.66 respectively. This suggests that the 'real' other-information variable mean reverts at approximately the same rate as real abnormal earnings. The adjusted R^2 is 0.43 and 0.48 for the yearly and pooled analyses, respectively. Again, value-relevant information appears to have a longer 'shelf-life' for UK firms.

(iii) Prediction of One Year Ahead Abnormal Earnings

Following DHS and McCare and Nilsson (2001), we investigate the ability of the two versions of the Ohlson model, the historical and the real model (and the three specifications of each model) to predict one-year ahead abnormal earnings. Table 4 reports the results for the two approaches that are used in this study. The mean forecast error (MFE) measures forecast bias, whilst the mean absolute forecast error (AFE) and the mean squared forecast error (SQFE) measure forecast accuracy. To reduce the influence of the heteroscedasticity, all forecast errors are scaled by market value. Furthermore, to reduce the effect of outliers, 1% of the forecast error outliers are omitted.[19] Panel A of Table 4 reports the forecast errors for each specification of the historical model, estimated on both yearly and pooled samples.

For the historical models, the pooled and yearly analyses including the other information variable provide the lowest forecast bias, with the worst performing specification being that which ignores the persistence of abnormal earnings parameter. In terms of forecast accuracy, the best specification appears to be the yearly analysis which includes a persistence parameter for abnormal earnings but not for the other information variable.

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[19] This is consistent with the approach employed in DHS and McCare and Nilsson (2001).

Table 4

Relative Forecasting Ability of Alternative Models for Predicting One Year Ahead Abnormal Earnings

Specification	*Mean Forecast Error (MFE)*	*Mean Absolute Error (AFE)*	*Mean Square Forecast Error (SQFE)*
Panel A: Historical Model			
$\omega = 0$	−0.084	0.125	0.062
Pooled analysis, $\omega = \omega^u$, $\nu = 0$	−0.041	0.060	0.015
Yearly analysis, $\omega = \omega^u$, $\nu = 0$	−0.032	0.051	0.012
Pooled and Yearly analysis, with ν	0.018	0.086	0.022
Panel B: Real Model			
$\omega = 0$	−0.011	0.104	0.043
Pooled analysis, $\omega = \omega^u$, $\nu = 0$	−0.007	0.049	0.010
Yearly analysis, $\omega = \omega^u$, $\nu = 0$	−0.005	0.045	0.008
Pooled and Yearly analysis, with ν	0.0004	0.091	0.029

Notes:
The sample covers the period from 1976–2000. Forecast errors are scaled by the market value of equity at the end of year t. The forecast error for year t is computed by subtracting the forecast of abnormal earnings for year $t+1$ from the realised abnormal earnings for year $t+1$. That is: $MFE_t = \left(X^a_{t+1} - E_t\left[X^a_{t+1}\right]\right)/MV_t$, where $E_t\left[X^a_{t+1}\right] = \omega X^a_t$ in the case where 'other information' is ignored, whilst $E_t\left[X^a_{t+1}\right] = f^{ca}_t = f^{ca}_t - r.BV_t$ in the case where other information is incorporated in the model.

Panel B of Table 4 reports the ability of the real model in predicting one-year ahead abnormal earnings. The results indicate that, as is the case for the historical model, the specification which includes the other information variable is the least biased by some margin, whilst in terms of forecast accuracy, the yearly analysis which includes a persistence parameter for abnormal earnings but not for the other information variable is the most accurate.

The real model produces both significantly lower forecast bias and better forecast accuracy than the historical model if we compare Panels A and B. The only exception to this is in the case of the models which include the other information variable, where the historical model is marginally more accurate.

Overall, these results indicate that incorporating the other information variable in the model improves its ability to predict one year ahead abnormal earnings. Comparing the two versions of the Ohlson model, the historical and the real models, indicate that the real model, as we expected, provides more accurate results in terms of predicting one period ahead abnormal earnings. The MFE is always smaller, and in general, the forecast accuracy is greater in the real model. This is perhaps not surprising given the violations of the Ohlson model found in the UK as a result of 'dirty surplus' accounting. In the historical model, substantial proportions of clean-surplus income will be omitted by crediting revaluations direct to reserves, whilst the uplift in asset values will impose a transitory shock on the residual income, or abnormal earnings, in the year following the revaluation. These shocks will not be present in the real model to the extent that asset prices rise in line with the general inflation rate. This suggests that the relative performance of the two models may vary with the inflation rate, and to investigate this we analyse the predictive performance by sub-periods. We separate years into those where inflation is 10% or more ('High'), those where inflation is between 5% and 10% ('Medium'), and those where inflation is less than 5% ('Low'). Table 5 presents the results of the sub-sample analysis of relative forecasting ability of the models for predicting one year ahead abnormal earnings. For the historical model, forecast bias increases and accuracy deteriorates in times of higher inflation. However, in the real model, predictions of one ahead abnormal earnings improve in periods of 'high' compared to periods of 'medium' inflation, though periods of very low inflation produce even lower forecast bias and greater accuracy still. This may be a function of the lagged effect of out of date asset values on residual income calculations during periods when inflation is falling.

(iv) Explaining Contemporaneous Stock Prices

This section examines the relative ability of the two versions of the Ohlson model, and the different specifications of each version, to explain contemporaneous stock prices. As noted above, in order to allow earnings and book value information to be fully reflected in market prices, we investigate the ability of the

Table 5

Relative Forecasting Ability of Alternative Models for Predicting One Year Ahead Abnormal Earnings- Sub sample Analysis

Specification	*Mean Forecast Error (MFE)*	*Mean Absolute Error (AFE)*	*Mean Square Forecast Error (SQFE)*
Panel A: Historical Model			
Inflation Rate > 10%			
$\omega = 0$	−0.139	0.188	0.115
Pooled analysis, $\omega = \omega^u$, $\nu = 0$	−0.067	0.092	0.027
Yearly analysis, $\omega = \omega^u$, $\nu = 0$	−0.045	0.067	0.018
Pooled and Yearly analysis, with ν	0.071	0.133	0.042
Inflation Rate 5–10%			
$\omega = 0$	−0.082	0.119	0.059
Pooled analysis, $\omega = \omega^u$, $\nu = 0$	−0.039	0.056	0.013
Yearly analysis, $\omega = \omega^u$, $\nu = 0$	−0.032	0.051	0.014
Pooled and Yearly analysis, with ν	0.007	0.076	0.019
Inflation Rate < 5%			
$\omega = 0$	−0.049	0.089	0.031
Pooled analysis, $\omega = \omega^u$, $\nu = 0$	−0.026	0.044	0.010
Yearly analysis, $\omega = \omega^u$, $\nu = 0$	−0.022	0.039	0.007
Pooled and Yearly analysis, with ν	−0.003	0.065	0.014
Panel B: Real Model			
Inflation Rate > 10%			
$\omega = 0$	0.013	0.143	0.054
$\omega = \omega^u$, $\nu = 0$ Pooled analysis,	0.005	0.071	0.015
$\omega = \omega^u$, $\nu = 0$ Yearly analysis,	0.010	0.061	0.011
ν Pooled and Yearly analysis, with	0.038	0.137	0.050
Inflation Rate 5–10%			
$\omega = 0$	−0.026	0.100	0.041
Pooled analysis, $\omega = \omega^u$, $\nu = 0$	−0.013	0.047	0.010
Yearly analysis, $\omega = \omega^u$, $\nu = 0$	−0.013	0.044	0.009
Pooled and Yearly analysis, with ν	−0.014	0.083	0.029
Inflation Rate < 5%			
$\omega = 0$	−0.008	0.083	0.037
Pooled analysis, $\omega = \omega^u$, $\nu = 0$	−0.007	0.038	0.006
Yearly analysis, $\omega = \omega^u$, $\nu = 0$	−0.007	0.035	0.005
Pooled and Yearly analysis, with ν	−0.008	0.068	0.016

Notes:
The sample covers the period from 1976–2000. Forecast errors are scaled by the market value of equity at the end of year t. The forecast error for year t is computed by subtracting the forecast of abnormal earnings for year $t+1$ from the realised abnormal earnings for year $t+1$. That is: $MFE_t = \left(X^a_{t+1} - E_t\left[X^a_{t+1}\right]\right)/MV_t$, where $E_t\left[X^a_{t+1}\right] = \omega X^a_t$ in the case where ‘other information’ is ignored, whilst $E_t\left[X^a_{t+1}\right] = f^{ca}_t = f^{ca}_t - r.BV_t$ in the case where other information is incorporated in the model.

model to explain stock prices six months after the fiscal year end. We measure this relative ability in two ways: (a) bias by the signed value of prediction error (VE), and (b) accuracy by the mean absolute value of prediction error (AVE) as well as the mean squared of the prediction error (SQVE). Table 6 shows the results for both models.

Panel A of Table 6 reports the results for the different specifications of the historical model, estimated on yearly and pooled bases. Note that since VE is (Market Value – Fundamental Value) divided by Market Value, a positive VE implies market prices are under-estimated by the fundamental valuation model, whilst a negative VE implies market prices are being over-estimated. Consistent with DHS and McCare and Nilsson (2001), we find that the historical model undervalues equities relative to the stock market in four specifications out of five. The

Table 6

Valuation Error by Comparing the Model's Estimated Values with Contemporaneous Stock Prices

Specification	*VE*	*AVE*	*SQVE*
Panel-A: Historical Model			
$\omega = 0$	−0.034	0.63	0.81
Yearly analysis, $\omega = \omega^u$, $\nu = 0$	0.093	0.59	0.85
Yearly analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	0.25	0.49	0.49
Pooled analysis, $\omega = \omega^u$, $\nu = 0$	0.022	0.58	0.67
Pooled analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	0.159	0.45	0.32
Panel B: Real Model			
$\omega = 0$	−0.106	0.67	0.96
Yearly analysis, $\omega = \omega^u$, $\nu = 0$	−0.080	0.64	0.90
Yearly analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	−0.092	0.62	0.80
Pooled analysis, $\omega = \omega^u$, $\nu = 0$	−0.098	0.64	0.84
Pooled analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	−0.107	0.62	0.80

Notes:
VE = (*MV* – Fundamental Value)/*MV*, AVE = |VE|, and SQVE = $(\text{VE})^2$. Fundamental value is $P = BV_t + \frac{\omega}{1+r-\omega} X_t^a + \frac{1+r}{(1+r-\omega)(1+r-\gamma)} \nu_t$. *MV* is the market value of equity six months after fiscal year end; *BV* is book value of equity, r is a 5% constant in the case of the *real model*. Abnormal earnings are defined as: $X_t^a = X_t - r.BV_{t-1}, \nu_t$ is the other information variable and is defined as: $\nu_t = f_t^{ac} - \omega X_t^a$, where f^{ac} is forecasted abnormal earnings based on Capstaff et al's procedure. That is, $f_t^a = f_t - r.RBV_t$, f_t is defined as: Industry (E/P)*Firm(P/E)*earnings, and *RBV* is the adjusted book value of equity. To reduce the effect of outliers, the top and bottom 1% signed valuation errors are omitted for each specification.

models that ignore the other information variable have valuation errors equal to 0.093 and 0.022 for the yearly and pooled analyses, respectively. The model that incorporates the ‘other information’ variable has the largest valuation error (VE = 0.25 and 0.159 for the yearly and pooled analyses, respectively). However, in terms of the measures of forecast accuracy, the models which incorporate the other information variable outperform the specifications, yearly or pooled, which exclude it (SQVE of 0.49 and 0.32 versus 0.85 and 0.67, respectively).

Panel B of Table 6 reports the results for the different specifications of the real model, estimated on yearly and pooled bases. The results indicate that the real model consistently overestimates stock prices. Thus, the real model replaces the undervaluation problem found in prior studies with an over-valuation problem. It is likely that to some degree this difference between models represents the differing approaches used to estimate the cost of capital. The largest valuation error is produced by the real pooled analysis which includes the other information variable, which has a VE of −0.107. However, there is little variation in valuation error across the specifications here with the best specification still giving a valuation error of −0.08. Disappointingly, the AVE and SQVE are always higher in the case of the real model than the historical model, and paradoxically the best model in terms of average valuation error (the yearly analysis ignoring ‘other information’) turns out to have the second largest AVE and SQVE of the alternative specifications. The most accurate real models in terms of forecast errors are the specifications which include the other information variables.

In order to shed more light on the reasons for the poor performance of these models in explaining stock prices, Table 7 presents the valuation error results for the sub-sample analysis. Interestingly, in periods of higher inflation, the historical model tends to overestimate prices whereas when inflation is lower, prices are underestimated by the models. The extent of valuation error appears dramatic compared to the whole-sample period models. The real model’s valuation problems also appear greatest in high inflation periods. Indeed, the overestimation problem is more acute in the real model and extends even to periods of ‘medium’ inflation. Why should these valuation errors be so extreme? In order to understand this, we need

Table 7

Valuation Error by Comparing the Model's Estimated Values with Contemporaneous Stock Prices- Sub-sample Analysis

Specification	*VE*	*AVE*	*SQVE*
Panel-A: Historical Model			
Inflation Rate > 10%			
$\omega = 0$	−0.629	0.821	1.55
Yearly analysis, $\omega = \omega^u$, $\nu = 0$	−0.367	0.726	1.41
Yearly analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	0.121	0.553	1.05
Pooled analysis, $\omega = \omega^u$, $\nu = 0$	−0.541	0.742	1.25
Pooled analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	−0.169	0.424	0.357
Inflation Rate 5–10%			
$\omega = 0$	0.059	0.601	0.706
Yearly analysis, $\omega = \omega^u$, $\nu = 0$	0.165	0.575	0.841
Yearly analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	0.239	0.474	0.340
Pooled analysis, $\omega = \omega^u$, $\nu = 0$	0.112	0.549	0.569
Pooled analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	0.211	0.456	0.322
Inflation Rate < 5%			
$\omega = 0$	0.252	0.545	0.435
Yearly analysis, $\omega = \omega^u$, $\nu = 0$	0.320	0.529	0.479
Yearly analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	0.340	0.465	0.282
Pooled analysis, $\omega = \omega^u$, $\nu = 0$	0.297	0.523	0.406
Pooled analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	0.319	0.474	0.303
Panel B: Real Model			
Inflation Rate > 10%			
$\omega = 0$	−0.778	0.935	1.92
Yearly analysis, $\omega = \omega^u$, $\nu = 0$	−0.732	0.925	1.83
Yearly analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	−0.729	0.903	1.72
Pooled analysis, $\omega = \omega^u$, $\nu = 0$	−0.776	0.915	1.74
Pooled analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	−0.763	0.893	1.67
Inflation Rate 5–10%			
$\omega = 0$	−0.012	0.627	0.845
Yearly analysis, $\omega = \omega^u$, $\nu = 0$	0.010	0.578	0.733
Yearly analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	−0.005	0.554	0.639
Pooled analysis, $\omega = \omega^u$, $\nu = 0$	−0.002	0.575	0.696
Pooled analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	−0.018	0.564	0.673
Inflation Rate < 5%			
$\omega = 0$	0.237	0.545	0.441
Yearly analysis, $\omega = \omega^u$, $\nu = 0$	0.255	0.528	0.464
Yearly analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	0.235	0.497	0.366
Pooled analysis, $\omega = \omega^u$, $\nu = 0$	0.247	0.520	0.404
Pooled analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	0.231	0.503	0.370

Notes:

VE = (*MV* – Fundamental Value)/*MV*, AVE = |VE|, and SQVE = $(\mathrm{VE})^2$. Fundamental value is $P = BV_t + \frac{\omega}{1+r-\omega} X_t^a + \frac{1+r}{(1+r-\omega)(1+r-\gamma)} \nu_t$. *MV* is the market value of equity six months after fiscal year end; *BV* is book value of equity, r is a 5% constant in the case of the *real model*. Abnormal earnings are defined as: $X_t^a = X_t - r.BV_{t-1}, \nu_t$ is the other information variable and is defined as: $\nu_t = f_t^{ac} - \omega X_t^a$, where f^{ac} is forecasted abnormal earnings based on Capstaff et al's procedure. That is, $f_t^a = f_t - r.RBV_t$, f_t is defined as: Industry (E/P)*Firm(P/E)*earnings, and *RBV* is the adjusted book value of equity. To reduce the effect of outliers, the top and bottom 1% signed valuation errors are omitted for each specification.

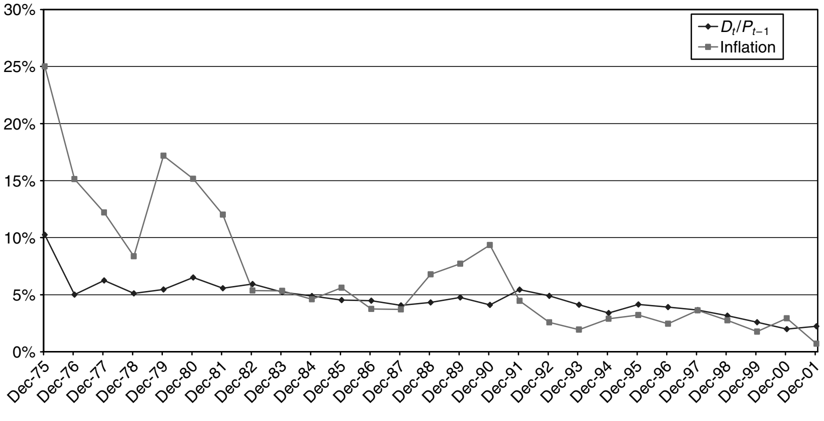
to look back at the pattern of historical valuations. One way of approaching this problem is to examine the expected return on equities implied by the real dividend yield, as described in Fama and French (Table 1, p. 641, 2002). We calculated the *real* yield using data on dividends and inflation from the *Barclays Capital Equity Gilt Study*, 2001. The average real yields for our high inflation years were 6.5%, for medium inflation years the figure was 4.9%, and for low inflation years the figure was 3.8% (see Figure 1). Our purpose here is not to discuss the market efficiency implications of these different valuations in times of inflation (though for views on this see Ritter and Warr, 2002; and O'Hanlon and Peasnell, 2004), but rather to note that relative valuations appear high in later low inflation periods, and low during high inflation periods. Our uplifts to book value will be greater during high inflation periods, which in part explains the results reported for the sub-periods.

(v) The Effect of Estimating Industry-Specific Persistence Parameters on the Empirical Implementations of the Ohlson (1995) Model

Lo and Lys (2000) argue that the Ohlson (1995) model should be adjusted to allow for information dynamic parameters that are firm specific, that is, the persistence parameter of abnormal

Figure 1

Real Dividend Yield (D_t/P_{t-1}) and Inflation



earnings, ω, and the persistence parameter of the 'other information' variable, γ, should be estimated for each firm. One problem that arises here is that this procedure requires data to be available for each firm for a prolonged time period, otherwise the estimation of these parameters will be biased. However, an alternative approach could be to estimate these parameters on an industry basis.[20] Thus, if the persistence parameters are expected to be different among firms, the industry approach to estimating these parameters is likely to result in less severe differences. Given that our focus is on the real model, and we only report the historical analysis above to facilitate comparison with previous non-UK studies, we undertake our industry analysis solely in terms of the real model. We use the general industry classifications that are employed in *DataStream*. Note that we could limit the estimation of the persistence parameters to a pooled analysis basis since the number of observations that are available for each year for some industries is too low. However, a yearly analysis is included for the purposes of illustration.

Tables 8 and 9 show the results for the autoregressive properties of abnormal earnings and for the 'other information' variable respectively, analysed on an industry basis. Panels A and B of Table 8 show that the values of the autoregressive coefficient, ω, fall within the extreme values of zero and one as hypothesised in the Ohlson (1995) model. In Panel A, for the pooled analyses, the Utilities industry has the highest persistence parameter of 0.91. The Information Technology and Resources industries produce the lowest persistence parameters of 0.37 and 0.45, respectively. The much higher persistence parameter of abnormal earnings for the Utilities industry is plausible since regulators set the prices for companies in this industry. Although one could expect that abnormal returns for this industry to be zero, to the extent that regulatory cost of capital may be higher than the 5% (real) figure used in this study, and that the UK 'RPI – x' price cap formula used in all regulated industries allows utilities to capture the present value of any efficiency gains achieved within the regulatory quinquennial period, abnormal returns may be persistent. The yearly analyses in

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[20] McCare and Nilsson (2001) follow this procedure.

Table 8

Autoregressive Properties of Abnormal Earnings – Industry Analysis

The autoregressive properties of abnormal earnings with one-lag are defined as:

$$X^{a}_{t+1} = \omega_0 + \omega_1 X^{a}_{t} + e_{i,t+1}$$

Industry	ω_0	ω_1	*Mean of Dep.*	*Adjusted-R^2*	*No. of Obs.*
Panel A: Pooled Analysis					
Basic	0.00	0.54	0.004	0.49	3415
	(0.39)	(23.54)			
Cyclical Consumer	−0.007	0.56	−0.013	0.52	2691
	(−3.24)	(20.72)			
Cyclical Services	0.002	0.57	0.008	0.58	5419
	(2.27)	(25.79)			
General Consumer	−0.004	0.55	−0.009	0.52	4563
	(−2.12)	(26.53)			
Information Technology	0.00	0.37	−0.001	0.38	803
	(0.10)	(8.49)			
Non Cyclical Consumer	0.005	0.58	0.014	0.63	1892
	(3.61)	(18.58)			
Non Cyclical Services	0.008	0.46	0.011	0.65	409
	(2.80)	(8.31)			
Resources	−0.005	0.45	−0.012	0.37	404
	(−1.78)	(6.63)			
Utilities	0.001	0.91	0.065	0.99	70
	(0.61)	(24.49)			
Panel B: Yearly Analysis					
Basic	−0.001	0.55	0.006	0.44	142
	(−0.19)	(10.98)			
Cyclical Consumer	−0.011	0.59	−0.016	0.47	112
	(−0.94)	(15.20)			
Cyclical Services	0.003	0.57	0.010	0.49	226
	(0.55)	(13.02)			
General Consumer	−0.005	0.55	−0.010	0.44	190
	(−0.66)	(13.20)			
Information Technology	0.004	0.35	0.003	0.28	50
	(1.26)	(4.92)			
Non Cyclical Consumer	0.006	0.61	0.019	0.52	79
	(1.52)	(7.86)			
Non Cyclical Services	0.003	0.80	0.009	0.65	17
	(0.62)	(6.11)			
Resources	−0.013	0.57	−0.024	0.41	19
	(−2.35)	(6.55)			
Utilities	–	–	–	–	–

Notes:
The sample covered the period 1976–2000. The number of firms represents the total number of observation over the sample period. To reduce the influence of heteroscedasticity, all variables are scaled by the market value of equity at the end of the period. We drop any observation for which the residuals are larger than three standard errors from the mean, to reduce the effect of outliers. All *t*-statistics are in parentheses with standard errors calculated using White (1980) corrections.

Panel B produce broadly consistent results with the pooled analyses, though the power of the models is in general diminished due to the relative paucity of the data, particularly for the Non-Cyclical and Resources Industries. The Utilities model is not estimated for the yearly analysis due to the prohibitively small number of company members of that industry.

Table 9 shows that the values of the autoregressive coefficient, γ_1, of the 'other information' variable for the pooled and yearly analyses fall within the extreme values of zero and unity as hypothesised in the Ohlson (1995) model, except for the Utilities industry which produces a coefficient marginally greater than zero. All values are significantly greater than zero.

In Panel B, the Non-Cyclical Services industry has the highest persistence parameter for other information of 0.87. The Information Technology and General Consumer industries produce the lowest persistence parameters of 0.38 and 0.50, respectively. The results for the other information variable are consistent with those of the abnormal earnings persistence parameter results. The results of the yearly models are again broadly consistent with the pooled models, though they are far less robust due to the paucity of data at cross-section compared to a pooled cross-section.

(vi) Prediction of One Year Ahead Abnormal Earnings Using Industry-Specific Persistence Parameters

This section aims to investigate the ability of the real model to predict one year ahead abnormal earnings after controlling for an industry effect in estimating the persistence parameters of abnormal earnings and the other information variable. Table 10 reports the forecast errors for the two specifications of the real model. The results indicate that the mean forecast error is -0.009 for the model that ignores the other information variable and 0.0004 for the model which includes this variable. Disappointingly, it seems that estimating abnormal earnings on an industry basis is actually less accurate than estimating them on a market-wide basis, in terms of MFE and AFE or SQFE for the pooled analysis when the other information variable is excluded. One point to note is that the mean forecast error for the model that incorporates the other information variable is not affected by the value of the persistence parameter

Table 9

Autoregressive Properties of the 'Other Information' Variable – Industry Analysis

The autoregressive properties of the 'other information' with one-lag are defined as:

$$\nu_{t+1} = \gamma_0 + \gamma_1 \nu_t + e_{i,t+1}$$

Industry	γ_0	γ_1	*Mean of Dep.*	*Adjusted-R^2*	*No. of Obs.*
Panel A: Pooled Analysis					
Basic	−0.005	0.44	−0.01	0.34	3466
	(−3.58)	(11.69)			
Cyclical Consumer	−0.002	0.68	−0.015	0.53	2753
	(−0.82)	(27.17)			
Cyclical Services	0.00	0.64	−0.005	0.59	5436
	(0.32)	(19.51)			
General Consumer	0.005	0.72	0.008	0.75	4642
	(4.46)	(14.03)			
Information Technology	0.005	0.38	0.011	0.23	800
	(2.48)	(8.1)			
Non Cyclical Consumer	0.006	0.68	0.016	0.60	1894
	(5.54)	(22.89)			
Non Cyclical Services	−0.001	0.58	−0.002	0.57	409
	(−0.53)	(8.86)			
Resources	−0.011	0.45	−0.021	0.24	409
	(−2.95)	(5.82)			
Utilities	0.004	1.06	−0.327	0.99	72
	(1.07)	(50.46)			
Panel B: Yearly Analysis					
Basic	−0.006	0.54	−0.015	0.42	142
	(−1.90)	(9.64)			
Cyclical Consumer	−0.001	0.71	−0.015	0.59	113
	(−0.16)	(12.81)			
Cyclical Services	−0.0002	0.61	−0.010	0.50	224
	(−0.11)	(11.74)			
General Consumer	0.003	0.53	0.004	0.37	190
	(1.16)	(12.90)			
Information Technology	0.003	0.40	0.009	0.26	45
	(1.40)	(4.83)			
Non Cyclical Consumer	0.006	0.63	0.012	0.54	78
	(2.69)	(14.31)			
Non Cyclical Services	0.0006	0.87	−0.003	0.62	17
	(0.23)	(5.59)			
Resources	−0.002	0.77	−0.016	0.39	19
	(0.27)	(3.73)			
Utilities	–	–	–	–	–

Notes:

The sample covered the period 1976–2000. The number of firms represents the total number of observation over the sample period. To reduce the influence of heteroscedasticity, all variables are scaled by the market value of equity at the end of the period. We drop any observation for which the residuals are larger than three standard errors from the mean, to reduce the effect of outliers. All *t*-statistics are in parentheses with standard errors calculated using White (1980) corrections.

Table 10

Relative Ability of the Real Model in Forecasting One Year Ahead Abnormal Earnings- Industry Analysis

Specification	*Mean Forecast Error (MFE)*	*Mean Absolute Forecast Error (AFE)*	*Mean Square Forecast Error (SQFE)*
Pooled Analysis, $\omega = \omega^u$, $\nu = 0$	−0.009	0.051	0.021
Pooled Analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	0.0004	0.091	0.029

Notes:
The sample covers the period from 1976–2000. Forecast errors are scaled by the market value of equity at the end of year t. The forecast error for year t is computed by subtracting the forecast of abnormal earnings for year $t+1$ from the realised abnormal earnings for year $t+1$. That is: $FE_t = \left(X^a_{t+1} - E_t\left[X^a_{t+1}\right]\right)/MV_t$, where $E_t\left[X^a_{t+1}\right] = \omega X^a_t$ in the case where 'other information' is ignored, whilst $E_t\left[X^a_{t+1}\right] = f^{ca}_t = f^c_t - r.BV_t$ in the case where other information is incorporated in the model.

of abnormal earnings, ω. Therefore, the figures are the same as those given in Panel B of Table 4 since these figures were already estimated using industry PE values to estimate the 'other information' parameter.

Table 11 gives the results for the relative ability of the real model in forecasting one year ahead abnormal earnings for the industry sub-sample analysis. Interestingly, the table exhibits movement from negative to positive bias as inflation increases from 'low' to 'high'. The 'high' inflation and 'low' inflation periods exhibit the lowest forecast bias whereas 'medium' inflation periods produce the highest forecast bias in predicting one year ahead abnormal earnings.

(vii) Explaining Contemporaneous Stock Prices Using Industry-Specific Persistence Parameters

We also investigate the relative ability of the real model to explain contemporaneous stock prices after controlling for an industry effect in estimating the persistence parameters of abnormal earnings and the other information variable. Table 12 reports the results for the different specifications of the real model estimated in the pooled analysis. The results indicate that the mean valuation errors are −0.08 and −0.085 for the model

Table 11

Relative Ability of the Real Model in Forecasting One Year Ahead Abnormal Earnings- Industry Analysis-Sub-sample Analysis

Specification	*Mean Forecast Error (MFE)*	*Mean Absolute Forecast Error (AFE)*	*Mean Square Forecast Error (SQFE)*
Inflation rate $> 10\%$			
Pooled Analysis, $\omega = \omega^u$, $\nu = 0$	0.004	0.070	0.021
Pooled Analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	0.038	0.137	0.050
Inflation rate 5–10%			
Pooled Analysis, $\omega = \omega^u$, $\nu = 0$	−0.017	0.051	0.035
Pooled Analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	−0.014	0.083	0.029
Inflation rate $< 5\%$			
Pooled Analysis, $\omega = \omega^u$, $\nu = 0$	−0.008	0.039	0.006
Pooled Analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	−0.008	0.068	0.016

Notes:

The sample covers the period from 1976–2000. Forecast errors are scaled by the market value of equity at the end of year *t*. The forecast error for year *t* is computed by subtracting the forecast of abnormal earnings for year $t+1$ from the realised abnormal earnings for year $t+1$. That is: $FE_t = \left(X^a_{t+1} - E_t\left[X^a_{t+1}\right]\right)/MV_t$, where $E_t\left[X^a_{t+1}\right] = \omega X^a_t$ in the case where 'other information' is ignored, whilst $E_t\left[X^a_{t+1}\right] = f^{ca}_t = f^c_t - r.BV_t$ in the case where other information is incorporated in the model.

that ignores the other information variable and the model that incorporates the other information variable, respectively. The measures of valuation accuracy show that incorporating the other information variable in the model marginally increases the model's ability to explain stock prices. For example, the mean absolute valuation error is 0.64 for the model that incorporates the other information variable versus 0.65 for the model that ignores the other information variable.

Comparing the above results with non-industry estimates (Table 6) yields the result that the over-valuation problem is somewhat less severe in the industry level models, although forecast accuracy as measured by AVE and SQVE is diminished somewhat.

Table 13 presents the results of sub-sample industry analysis of the valuation error when comparing the model's estimated

Table 12

Valuation Error from Comparing the Model's Estimated Values with Contemporaneous Stock Prices- Industry Analysis

Specification	*VE*	*AVE*	*SQVE*
Pooled Analysis, $\omega = \omega^u$, $\nu = 0$	−0.08	0.65	0.87
Pooled Analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	−0.085	0.64	0.85

Notes:
VE = (*MV* − Fundamental Value)/*MV*, AVE = |VE|, and SQVE = $(\text{VE})^2$. Fundamental value is $P = BV_t + \frac{\omega}{1+r-\omega} X_t^a + \frac{1+r}{(1+r-\omega)(1+r-\gamma)} \nu_t$. *MV* is the market value of equity six months after fiscal year end; *BV* is book value of equity, r is a 5% constant in the case of the *real model*. Abnormal earnings are defined as: $X_t^a = X_t - r.BV_{t-1}$, ν_t is the other information variable and is defined as: $\nu_t = f_t^{ac} - \omega X_t^a$, where f^{ac} is forecasted abnormal earnings based on Capstaff et al's procedure. That is, $f_t^a = f_t - r.RBV_t$, f_t is defined as: Industry(E/P)*Firm(P/E)*earnings, and *RBV* is the adjusted book value of equity. To reduce the effect of outliers, the top and bottom 1% signed valuation errors are omitted for each specification.

values with contemporaneous stock prices. Interestingly, in 'medium' inflation periods, stock prices are least biased whereas in times of lower inflation stock pricing is more accurate. The general pattern of these results is similar to that already discussed for the market wide model above.

6. SUMMARY AND CONCLUSIONS

The aim of this paper was to develop and test an inflation-adjusted or 'real' version of the Ohlson model to attempt to establish asset values that proxy for economic values, such that abnormal returns may reasonably be expected to revert to a mean of zero. In addition, we also tested a historical version of the model in order to facilitate comparison with previous research.

For both the historical and real models, we found that the autoregressive properties of the persistence parameters of abnormal earnings and the 'other information' variable fall between the extreme values of zero and one as hypothesised in the Ohlson (1995) model. Furthermore, for the inflation-adjusted model, consistent with the Ohlson model assumption, we find that the second-period lag of the autoregressive process of abnormal earnings bordering on being insignificant. Importantly, at least in the cross-sectional auto-regression analysis, the inflation

Table 13

Valuation Error from Comparing the Model's Estimated Values with Contemporaneous Stock Prices- Industry Analysis- Sub-sample Analysis

Specification	*VE*	*AVE*	*SQVE*
Inflation rate > 10%			
Pooled Analysis, $\omega = \omega^u$, $\nu = 0$	−0.757	0.909	1.81
Pooled Analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	−0.739	0.888	1.72
Inflation rate 5–10%			
Pooled Analysis, $\omega = \omega^u$, $\nu = 0$	0.011	0.600	0.724
Pooled Analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	0.001	0.594	0.725
Inflation rate < 5%			
Pooled Analysis, $\omega = \omega^u$, $\nu = 0$	0.268	0.538	0.419
Pooled Analysis, $\omega = \omega^u$, $\gamma = \gamma^u$	0.256	0.529	0.407

Notes:
VE = (*MV* – Fundamental Value)/*MV*, AVE = |VE|, and SQVE = $(\mathrm{VE})^2$. Fundamental value is $P = BV_t + \frac{\omega}{1+r-\omega} X_t^a + \frac{1+r}{(1+r-\omega)(1+r-\gamma)} \nu_t$. *MV* is the market value of equity six months after fiscal year end; *BV* is book value of equity, r is a 5% constant in the case of the *real model*. Abnormal earnings are defined as: $X_t^a = X_t - r.BV_{t-1}$, ν_t is the other information variable and is defined as: $\nu_t = f_t^{ac} - \omega X_t^a$, where f^{ac} is forecasted abnormal earnings based on Capstaff et al's procedure. That is, $f_t^a = f_t - r.RBV_t$, f_t is defined as: Industry(E/P)*Firm(P/E)*earnings, and *RBV* is the adjusted book value of equity. To reduce the effect of outliers, the top and bottom 1% signed valuation errors are omitted for each specification.

adjusted model has an insignificant intercept term, which stands in contrast to the historical model and the DHS result.

We also investigate the relative ability of the two versions of the Ohlson model in predicting one period ahead abnormal earnings, we find that the real model provides more accurate results than those of the historical model in terms of mean forecast error. However, when we explore the models' ability to explain contemporaneous stock prices, we find that, consistent with prior research, the historical model undervalues stock prices in three specifications out of five. By contrast, the inflation-adjusted model almost always overestimates stock prices whatever the specification used. Our sub-period analysis shows that this over-valuation is most marked during periods of high inflation. These periods are those where market valuations exhibit high real dividend yields.

In addition, this paper provides an empirical assessment of the persistence parameter of abnormal earnings and the persistence parameter of the 'other information' variable using an industry-level analysis. We find that whilst the autoregressive properties of the persistence parameter of abnormal earnings and the persistence parameter of the 'other information' variable fall within the extreme values of zero and one as hypothesised in the Ohlson (1995) model, controlling for an industry effect in estimating the parameters leads to no significant improvement in predicting either abnormal earnings or contemporaneous stock prices.

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