The Evaluation of Accounting-Based Valuation Models In the UK

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ABSTRACT

This study provides two empirical studies in market-based accounting research. One study focuses on using out-of-sample valuation errors to evaluate various estimation approaches for firm-valuation models. The second empirical study uses portfolio analysis to evaluate an empirical accounting-based firm valuation model developed in the UK context.

The first study uses out-of-sample valuation errors as an alternative metric capturing the effectiveness of various estimation approaches in generating reliable estimates of coefficients in accounting-based valuation models and, accordingly, less valuation bias and higher valuation accuracy. Valuation bias is expressed as the mean proportional valuation error, where estimated market value less the actually observed market value divided by the actual market value is the proportional valuation error, and valuation accuracy is measured by both the mean absolute and the mean squared proportional valuation error.

We find that deflating the full equation including the constant term of the undeflated model and, hence, estimating without a constant term in the deflated model provides less bias and more accurate value estimates relative to including a constant term in the regression equation. Also estimating the valuation model on high- and low-intangible asset firms separately, instead of pooling the full sample for estimation, provides better performance in all cases. As expected, the results suggest that an extended model including the main accounting variables found to be associated with market value in the UK is better specified than a benchmark model, widely adopted in prior research, where market value is regressed on book value and earnings alone. Inclusion of ‘other information’ also seems to improve the performance of the models. However, there is no clear evidence that one particular deflator out of the five we investigate outperforms the others, although book value and opening and closing market value appear to generally perform better than sales and number of shares.

The second empirical study tests for the existence of a “mispricing” effect associated with accounting-based valuation models in the UK. It investigates a specific firm valuation model where market value is expressed as a linear combination of book value, earnings, research and development expenditures, dividends, capital contributions, capital expenditures and other information. All these accounting variables have been found value-relevant in prior studies in the UK. Firms are ranked by in-sample proportional valuation errors. Results show that although firms in the higher rank deciles tend to have higher abnormal returns than firms in the lower rank deciles, the difference between the two extreme portfolios (or the hedge returns) is statistically insignificant. As a consequence, accounting-based valuation models do not seem to provide superior estimates of intrinsic value to market values. We can conclude that the UK stock market is semi-strong form efficient, in the sense that it does not appear to be possible to generate positive abnormal returns based upon publicly available accounting information embedded in the valuation models studied.
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Yun Shen

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I dedicate this work to my parents, my husband, our lovely daughter

YiLin, and also my supervisor Andy…
1.1 Motivations of this study

It is widely acknowledged that a major breakthrough in academic studies of financial accounting took place in the 1960’s when accounting researchers began to focus on identifying the links between accounting information and the workings of capital markets. Value relevance studies, which have attracted significant attention from accounting researchers over the last decade, investigate the empirical association between stock market values (or changes in values) and various accounting numbers for the purpose of assessing those numbers’ usefulness in equity valuation. Underlying these tests is the idea that stock markets are at least efficient with respect to publicly available information and, as a consequence, the existence of a (partial or otherwise) correlation between an accounting item and market prices suggests it is ‘value relevant’. Implicit in this idea is that market prices are sensible estimators of firms’ intrinsic values, at least with respect to the information contained in publicly available information.

Value relevance studies often employ valuation models to structure their tests, and to make inferences concerning the coefficients of the accounting amounts in the estimation equation. As implied by the previous paragraph, some studies test whether the coefficient on the accounting amount being studied is significantly different from zero with the predicted sign. Rejecting the null hypothesis of no relationship is interpreted as
evidence that the accounting amount is relevant and not totally unreliable. Other studies test whether the estimated coefficient on the accounting amount being studied is different from those on other specified amounts recognized in financial statements. Rejecting the null that the coefficients are the same is interpreted as evidence that the accounting amount being studied has relevance and reliability that differs from the specified amounts.

Some empirical studies analyse the problems caused by running regressions on samples that contain firms of different size, or scale, a common feature of capital markets-based accounting research. For studies using firm level data, the magnitudes of the dependent variables depend largely, but not entirely, on the scale of the observation. In short, large (small) firms tend to have large (small) values of many variables, such as market value, earnings and book value of equity, etc. Scale is usually not of direct interest to researchers. However, the influence of scale in regressions can lead to a number of econometric problems, including: (i) coefficient bias, possibly induced by omitted correlated variables, in which the mean of the distribution of estimated coefficient deviates from the true coefficient; (ii) $R^2$ bias, where the estimated explanatory power $R^2$ is different from the true $R^2$; and (iii) heteroscedasticity, where the error terms are not drawn from the same population and, hence, bias the standard errors, as well as affecting the power of $t$ tests. These issues have been related to scale and scale effects in market-based accounting research.

To avoid inappropriate inferences drawn from the estimation results, most value relevance research employs well-established techniques to mitigate the effects of various
econometric issues that arise in their studies. Most accounting research deflates the valuation model by some measure of “size”, or uses White (1980) consistent standard error and covariance estimates when obtaining t-statistics, or both, to reduce the effects caused by these econometric problems, without going into much detail about the essence of these issues and the effects of these measures adopted.

Barth and Kallapur (1996) use simulated data to establish the “true regression”, develop expressions for coefficient bias and heteroscedasticity-related standard error bias, and reach conflicting conclusions regarding whether deflation of variables by a scale proxy or inclusion of a scale proxy as an additional explanatory variable in the estimated equation best mitigates any scale effects. Brown, Lo and Lys (1999), Guo and Ziebart (2000) and Gu (2005) focus on the effects of scale on $R^2$, the difference between the estimated $R^2$ and the $R^2$ that would be obtained using scale-free data. Gu (2005) concludes that the examination of the effects of scale-controlling mechanisms is impossible because, in order to do so, researchers would need to know both the scale-free economic relationship and the variability of the scale factor – both of which are unknown.

A more recent study on scale and scale effects, Barth and Clinch (2009), contributes to the discussion with respect to solving econometric issues endemic to much capital markets research by summarizing five forms of scale effects: (i) multiplicative scale; (ii) additive scale (omitted scale-related variables); (iii) scale-varying parameters; (iv) survivorship; and (v) scale-related heteroscedasticity. By so doing, they provide a more comprehensive analysis than prior studies, with substantially increased clarity of focus. However, their approach of using simulated data to draw conclusions about optimal
estimation approaches is still open to discussion. The debate over the most effective estimation specification to mitigate scale-related econometric problems, overall, remains unresolved.

This thesis aims to contribute to this literature by using an alternative criterion to evaluate estimated models - out-of-sample valuation errors. An out-of-sample valuation error is the difference between the estimated market value from a model estimated using other data and the actual firm value divided by the actual firm value. This underlying metric has been used before in evaluating the performance of valuation models. In particular, Dechow, Hutton and Sloan (1999) and Choi, O’Hanlon and Pope (2006) evaluate the Ohlson valuation model (1995) and a conservatism-adjusted Ohlson valuation model respectively using US data. The logic is straightforward. A superior valuation model should be less biased and more accurate in its value estimates than an inferior valuation model. By extension, and intuitively, the individual coefficient estimates embedded within a superior valuation model can be argued to be more reliable than those embedded within an inferior valuation model and, as a consequence, inferences drawn from the former are more reliable than those drawn from the latter. This criterion provides an alternative to the criterion used within the existing literature mentioned above (Barth and Clinch, 2009, among others), where simulated data is used to generate a “true regression” and bias is measured by the difference between the mean of estimator of the coefficient value and “true coefficient”.

Though this study adopts out-of-sample valuation errors as the effectiveness criterion, it differs from Dechow, Hutton and Sloan (1999) and Choi, O’Hanlon and Pope (2006) by

The typical base model used to structure value relevance studies in the US, and analysed by Barth and Clinch (2009) represents market value initially as a function of book value and earnings. Subsequently, accounting variables of particular interest are added into the model and tested for statistical significance and, hence, value relevance. The first research question raised in our study is whether those additional accounting variables found to be empirically associated with market value should be included in the base model that only contains book value and earnings to form a better specified benchmark model for value relevance studies. In particular, we compare this extended model against
the base model often used in value relevance studies mentioned above. We also include a variable to capture ‘other information’, using the approach of Akbar and Stark (2003a), to investigate the impact of ‘other information’ on model specifications. Further, we compare the performance of different deflators, all of which have been viewed as proxies for scale and have been used in prior value relevance studies when estimating the firm valuation models. We intend to evaluate the performance of different deflators against our specified criterion discussed above.

Given a deflator, a further estimation issue arises in value relevance studies based upon firm (undeflated) valuation model equations. One line of logic (mainly based upon the idea that the ‘scale effect’ is heteroscedasticity) is that the valuation equation should be divided through by the deflator. As a consequence, the deflated valuation model only contains a constant term if the deflator is a variable in the undeflated equation. Furthermore, the inverse of the deflator is also a variable in the estimated equation. Many studies in the value relevance literature, however, do not adopt this approach. Instead, they deflate the dependent and independent variables by a chosen deflator and substitute the deflated variables for the undeflated variables in the valuation model and proceed as if this approach is equivalent to estimating the undeflated model. In effect, however, it is equivalent to including the deflator as a variable in the undeflated valuation equation. As Akbar and Stark (2003a) point out, comparing deflators under this approach cannot be separated from comparing competing valuation models. As a

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1 Ohlson (1995) defines “other information” as other value relevance information that helps predict accounting information, but cannot be directly derived from it. Akbar and Stark (2003a) find that “other information” is value relevant, and the approach they use to proxy for “other information” is discussed in section 2.2.3.8 below.
consequence of the above, we also compare the performance of deflated models which include constant terms with the performance of those that do not.

Last but not the least, following prior research (Choi, O’Hanlon and Pope, 2006), which suggests that the impact of accounting conservatism is likely to differ between high-intangible and low-intangible sectors, we estimate valuation models separately on high-intangible firms and low-intangible firms, to see if this process provides superior performance, in conjunction with the various model specifications investigated.

To summarize, this study is intended to contribute to existing literature by investigating various model specification issues associated with value relevance studies. We suggest using an alternative criterion for evaluating the appropriateness of various model specifications and estimation approaches within the context of value relevance studies. Our criterion is to use out-of-sample proportional valuation errors.

Additionally, this thesis investigates if accounting-based valuation models, where market value is regressed on accounting variables found to be value relevant in previous studies in the UK, can be used to develop profitable portfolio strategies. Underlying such an experiment is the underlying theory of semi-strong form market efficiency, and existing evidence of accounting anomalies, especially those associated with accounting-based valuation models.

The semi-strong form of the Efficient Market Hypothesis (EMH) suggests that market prices fully reflect all publicly available information, including past prices and returns,
current and past financial statement data, and information contained in financial press releases, *etc.* Grossman and Stiglitz (1980), however, suggest that, in the presence of costly information acquisition and processing, prices cannot be fully revealing. A general implication of this type of argument is that, all other things being equal, the more difficult and, hence, the more costly the information is to acquire, the less the current price will reflect or reveal the implications of this information for future prospects.

Existing empirical evidence is not totally consistent with these ideas because, despite accounting information being relatively cheap to acquire and process, there are examples in the literature of apparently profitable portfolio strategies based upon relatively cheap accounting information and with relatively low information processing costs (for instance, post-earnings announcement drift (Ball and Brown, 1968) and the accruals anomaly (Sloan, 1996), amongst others). There is also evidence associated with accounting-based valuation models. Dechow, Hutton and Sloan (1999) suggest that, when Ohlson’s residual income valuation model is used on US data, a portfolio strategy based on valuation errors can produce significant positive abnormal hedge returns of between 7% and 10%. Gregory, Saleh and Tucker (2005) conduct a similar test of a modified version of the Ohlson model (1989, 1995) with inflation adjustments in the UK and their results again show the possibility of a profitable investment strategy based upon valuation errors.

Given the above, we aim to contribute to the existing literature by conducting fundamental analysis with respect to the extended firm valuation model developed within the UK context, assuming that (some) accounting-based valuation models might provide
superior estimates of firms’ intrinsic values relative to observed stock market values. We form decile portfolios by ranking firms using the difference between predicted model value and observed equity value, the difference divided by the latter. The rational is straightforward. If we assume the valuation model tested is unbiased, the predicted model value can then be treated as a proxy of the intrinsic equity value. Lower deciles consist of stocks that are relatively overpriced and are, therefore, expected to experience relatively lower future abnormal stock returns. Higher deciles consist of stocks that are relatively underpriced and are, therefore, expected to experience higher future abnormal stock returns.

This study differs from Dechow, Hutton and Sloan (1999) and Gregory, Saleh and Tucker (2005), who specifically test theoretical valuation models which require the estimation of systems of linear information dynamics, by focusing on an empirical accounting-based firm valuation model where market value is expressed as a linear combination of accounting variables that have been found to be associated with market value in prior UK studies, such as book value, earnings, dividends, research and development expenditures, capital contributions, capital expenditures and ‘other information’.

If it is found that profitable portfolio strategies can be developed from these particular accounting-based valuation models tested, it would suggest that market prices do not fully reflect the publicly available information contained in accounting information, a suggestion that would challenge the idea that cheap to acquired and/or process accounting information should be well reflected in market values, the basis for value
relevance studies. Further, it also suggests that the studied accounting-based valuation models are capturing, to some extent, the intrinsic value of firms.

If no such portfolio strategies are identified, the outcome suggests that the accounting-based valuation models studies do not offer superior estimates of intrinsic value relative to market value. This outcome would be consistent with a number of possibilities. For example, it could be the case that the search for portfolio strategies is not exhaustive enough. Or, both methods of estimating intrinsic value do so adequately, and with uncorrelated random errors. If the latter is the case, the accounting-based valuation model could be capturing intrinsic value, in addition to market value so doing. But one implication of such findings is that market prices reasonably reflect the information in accounting-based valuation models and the theoretical underpinnings of value relevance studies are supported. Hence, it provides, at the minimum, a test of the level of informational efficiency with respect to such empirical accounting-based valuation models. The remainder of this chapter is organised as follows. Section 1.2 discusses the potential implications of this research. Section 1.3 outlines the structure of the thesis, and section 1.4 provides a brief summary.

1.2 Potential implications

This study should provide useful indications to researchers investigating the value relevance of accounting information. In recent years, there is a growing concern in the accounting community that historical cost financial statements have lost their value relevance. For example, this concern is expressed in Elliott (1995, p. 118)
“A large part of the immediate problem is the limited usefulness of today's financial statements. They don’t, for example, reflect information-age assets, such as information, capacity for innovation, and human resources. As a consequence, they have been a declining proportion of the information inputs to investors’ decision making.”

As a consequence, accounting researchers have been motivated to investigate the value relevance of accounting information. Brown, Lo and Lys (1999) argue that some findings are unreliable in the presence of scale and the price model is affected by scale. Hence, scale effects could hold the key to explaining possibly inconsistent results in prior value relevance studies. In this study, out-of-sample valuation errors are used as an alternative criterion to evaluate various model specifications designed to cope, at least partly, with scale issues thought to be arising in value relevance studies, which hopefully will provide insight for future researchers.

Additionally, the thesis provides fundamental analysis on firm valuation models that include all the main accounting variables found to be value-relevant in the UK. This provides a test whether the UK market reasonably reflects historical accounting information revealed in financial statements.

1.3 Structure of the thesis

This thesis proceeds as follows. Chapter 2 reviews various streams of relevant literature. The chapter initially provides an overview of the value relevance research and
econometric issues associated, as well as the Ohlson model widely employed in the value relevance research. It then provides a review of literature on the evaluation of accounting-based valuation models using out-of-sample valuation errors. In particular, studies on scale and scale effects are reviewed and discussed. Further, literature on fundamental analysis is discussed. A brief summary then concludes the chapter.

Chapter 3 covers the research methodologies used in this thesis. The chapter discusses how the examined models and model estimation procedures will be evaluated; shows the process of deriving the firm valuation models, discusses various specification issues associated with the empirical estimation of firm valuation models; discusses how decile portfolios are formed using valuation errors generated from the firm valuation model; and discusses how to measure portfolio performance based upon appropriate risk control methods.

Chapter 4 describes the process of data collection and the measurement of the relevant variables. It identifies the procedure followed in the data treatment steps, and presents the definitions of variables. More importantly, this chapter provides some initial regression results, so as to benchmark the value relevance with respect to the accounting variables included in the models against the findings of prior studies in the UK.

The main body of the dissertation are the two empirical studies presented in chapters 5 and 6. Chapter 5 presents the results of using out-of-sample valuation errors as an alternative metric capturing the effectiveness of various estimation approaches in generating reliable estimates coefficients in accounting-based valuation models, and
accordingly, less valuation bias and higher valuation accuracy. Chapter 6 investigates if accounting-based valuation models, where market value is regressed on accounting variables found to be value relevant in previous studies in the UK, can be used to develop profitable portfolio strategies.

Chapter 7 is the final chapter of the thesis. It summarises all the findings in the empirical chapters, and concludes the thesis by describing limitations and making some suggestions for further research.

1.4 Summary

This thesis provides two empirical studies in market-based accounting research. One study focuses on using out-of-sample valuation errors to evaluate various estimation specifications in value relevance studies. The second empirical study provides a fundamental analysis of the firm valuation model developed in the UK context. In summary, this chapter provides an overview of the thesis, by discussing the purpose of this study and outlining the structure of the thesis.
CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

As two important strands of capital market accounting research after the 1960’s, market-based accounting research and fundamental analysis have been conducted to shed some light on how financial statements are useful for the purpose of company valuation. Market-based accounting research considers financial statements as a reflection of past financial transactions, believes that the underlying value of a firm can be measured by its stock price and, hence, examines how accounting data reflects or correlates with the intrinsic value of the firm, or change in the value of the firm. Contrastingly, some researchers focusing on fundamental analysis view financial reports as an important source of information for estimating the underlying or intrinsic value of a firm, and try to use the information to develop portfolio investment strategies to earn excess returns from the market.

As a point of departure for empiricism in market-based accounting research, the Ohlson modelling approach (Ohlson 1995 and Feltham and Ohlson 1995), particularly the framework of linear information dynamics (LID), has been seen as a guide for cross-sectional valuation researchers in structuring the relationship between accounting data and firm value (Bernard, 1995). In the US, empirical studies by Dechow Hutton and Sloan (1999), Myers (1999), and Callen and Morel (2001) provide ambiguous empirical support for the Ohlson model (Ohlson 1995). Testing the Feltham-Ohlson model (1995),
Callen and Segal (2005) find their empirical results disencouraging and suggest indicate that the Ohlson model is of limited empirical validity (Callen and Segal, 2005, p3). Nonetheless, Ohlson’s LID is still considered as a useful framework for empirical research.

Value relevance studies, which have attracted significant attention from accounting researchers over the last decade, investigate the empirical association between stock market values (or changes in values) and various accounting numbers for the purpose of assessing those numbers’ usefulness in equity valuation. The Ohlson model is widely adopted in prior research as a basis to structure value relevance studies. The first stream of research discussed within this chapter is the literature that uses the Ohlson model as the basis for their analysis of value relevance of accounting items, and we focus on those studies conducted in the UK context.

When regressions are run on cross-sectional data, a series of econometric problems occur due to the fact that the samples contain firms of different size. This is studied by some authors and referred to generally as the scale effect, a common feature of capital markets-based accounting research. These problems can include a variety of econometric issues such as coefficient bias, $R^2$ bias, heteroscedasticity and, overall, incorrect inferences. Prior literature tends to either leave the nature of the scale effect studied ambiguous or only study one possible scale effect, Barth and Clinch (2009), however, analyse five forms of scale effects: (i) multiplicative scale; (ii) additive scale (omitted scale-related variables); (iii) scale-varying parameters; (iv) survivorship; and (v) scale-related
heteroscedasticity; and provide a more ambitious and comprehensive analysis than prior studies, with substantially increased clarity of focus.

However, Barth and Clinch (2009) raise a number of important issues with respect to solving econometric issues endemic to much capital markets research. Their methodology of using simulated data to draw conclusions about optimal estimation approaches is open to discussion, however. The second stream of studies reviewed in this chapter are then related to scale and scale effect, and we identify the gap in prior studies and, hence, propose to use an alternative metric of out-of-sample valuation errors to evaluate various model specifications.

Furthermore, Akbar and Stark (2003b) in the UK suggest that firm value can be modelled as a linear function of value-relevant accounting variables, particularly, book value, earnings, research and development expenditure, dividends and capital contributions. They also argue that empirical results in the US do not automatically carry over into the UK (Akbar and Stark 2003b, p1230). Further literature review is then provided focusing on fundamental analysis studies, as we propose to evaluate firm valuation models using this approach, (i.e., investigate whether cross-sectional valuation models developed in the UK context can be used to develop investment strategies, and generate positive abnormal returns).

This chapter reviews the research background and highlights various streams of relevant literature. The remainder of this chapter is organized as follows. The rest of section 2.1 reviews value relevance studies and the Ohlson models that are widely employed to
assess the value relevance of accounting numbers, furthermore, econometric problems associated with these studies. Section 2.2 focuses on relevant studies on scale and scale effect, as well as the literature using out-of-sample valuation errors to evaluate firm valuation models. Section 2.3 provides a review of literature relevant to using valuation models for portfolio investment strategies. A brief summary in section 2.4 concludes the chapter.

2.2 Research background: value relevance of accounting numbers

The association between accounting numbers and security prices/market value is a matter of longstanding interest in capital market research. This study focuses on assessing accounting-based valuation models in the UK context, and these models are developed and employed by value relevance studies which investigate the linkage between accounting variables and equity prices. It is then necessary to briefly review value relevance studies in this context.

A few studies (e.g., Beaver, 1998, Ohlson, 1999, Barth 2000, and Barth, Beaver and Landsman, 2001) have provided formal definitions of the term “value relevance”, among which Barth, Beaver and Landsman (2001) summarize the previous studies and suggest that an accounting number is defined as value relevant if it has a predicted association with equity market values. The association between accounting numbers and security prices/market value is a matter of longstanding interest in capital market research. Early studies, such as Ball and Brown (1968) and Beaver (1968), demonstrate that stock returns are correlated with earnings surprises. Kothari (2001), who provides a review of
capital market research, reviews Ball and Brown (1968) and Beaver (1968) as the “pioneering studies in capital markets research” and that “the decades following the early research witnessed an explosive growth in capital market research”.

2.2.1 Methods of assessing value relevance of accounting numbers

Value relevance studies can be classified into three categories (Lambert, 1996, and Holthausen and Watts, 1996, p2). First, relative association studies compare the association between stock market values (or changes in values - returns) and alternative bottom line measures. These studies usually test for differences in the $R^2$ of a regression. The accounting number with the greater $R^2$ is described as being more value relevant. Second, there are incremental association studies which usually use regressions to investigate whether the accounting number of interest is helpful in explaining value or returns (over long windows), given other specified variables. That accounting number is typically deemed to be value relevant if its estimated regression coefficient is significantly different from zero. Third, marginal information content studies investigate whether a particular accounting number adds to the information set available to investors. They typically use event studies (short window return studies) to determine if the release of an accounting number (conditional on other information released) is associated with value changes. Price reactions would be considered evidence of value relevance.

Similarly, Kothari (2001) identifies two types of returns-based value relevance studies: (i) event studies; and (ii) association studies. Both Ball and Brown (1968) and Beaver
(1968) perform an event study, and Ball and Brown (1968) also conduct an association study. Both types of studies are briefly discussed here.

### 2.2.1.1 Event studies


These studies focus on the question of whether accounting information, earnings announcements in particular, conveys information about future cash flows. However, the basic form of the event study methodology raises a number of important concerns. First, it relies upon the ability to precisely identify the timing of the announcement in terms of when it can be expected that the market will learn about and react to the announcement. Nonetheless, researchers investigating these sorts of questions tend to finesse these difficulties by using an ‘event window’. The event window results from identifying a small period of days which have a high probability of containing the day of the announcement and associated stock market reaction.

A second concern related to the event study methodology is that the investigation strategy appears to assume that, in the absence of the announcement, the market receives no other valuation-relevant information to disturb the predicted relationship between the opening and closing prices for each day under investigation. This assumption is unlikely...
to be true because market participants continually receive valuation-relevant information that causes them to revise expectations of further prospects and, hence, stock prices. As a consequence, it is inappropriate to attribute to the announcement the whole of any departure from the closing price predicted by the assumed theoretical relationship between the opening and closing prices for the day in the absence of the announcement. The above concerns notwithstanding, the event study methodology assumes that, on average, any other information that arrives either during the event window or in the studied period after the event window is neither consistently good news (causes prices to increase) nor bad news (causes prices to decrease). Under such circumstances, considering announcement effects across large group of firms, in effect, will cancel out (or, at least, substantially reduce) the effects of the other information arrivals.

A third and crucial problem is the necessity of assuming a particular theory of security pricing or returns. Any particular security pricing model present the potential problem of missing determinant factors affecting stock returns. Although the CAPM is one model of security pricing, researchers tend to use what can be used as a simpler version of the CAPM, namely the “market model”, and one criticism associated with using CAPM to generate abnormal returns in research design is the missing determinant factors, such as firm size and market to book ratio, etc. Also these security pricing models are generally developed within the US context, and taking the Fama and French model for an example, Michou, Mouselli and Stark (2010) have shown that it is by no means clear that one can simply "lift" this ad hoc model and apply it literally in the UK.
2.2.1.2 Association studies

An association study, according to Kothari (2001, p12), “tests for a positive correlation between an accounting performance measure (e.g., earnings or cash flow from operations) and stock returns, both measured over relatively long, contemporaneous time periods, e.g., one year. Since market participants have access to many more timely sources of information about a firm’s cash flow generating ability, association studies do not presume that accounting reports are the only source of information to market participants. Therefore, no causal connection between accounting information and security returns over a given period.” Examples of association studies include Ball and Brown (1968), Beaver and Dukes (1972), Beaver, Lambert, and Morse (1980), Beaver, Griffin and Landsman (1982), Rayburn (1986), Easton and Harris (1991), Strong and Walker (1993), Easton, Harris and Ohlson (1992), Dechow (1994), Green (1999) and Dhaliwal, Subramanyam and Trezevant (1999), among many others.

2.2.1.3 Returns and levels regression models

Both returns (association studies in particular) and levels approaches, in principle, require theories of the relationship between accounting information and market value. Further, theories of security valuation theory suggest that where, theoretically, a particular accounting amount is value relevant, this should be evident in either approach. Different researchers, however, have argued about the advantages and disadvantages of returns and levels approach – see, for example, Gonedes and Dopuch (1974), Lev and Ohlson (1982), Christie (1987), and Kothari and Zimmerman (1995), amongst others.
Gonedes and Dopuch (1974) support the theoretical superiority of the returns approach. Lev and Ohlson (1982) provide a review of studies that incorporate a number of research methodologies in prior market-based accounting research, and they argue that the value relevance of a particular accounting variable critically depends on the model used and the exact timings of the information disclosure. They also argue that level models are less sensitive to model specification issues relative to return models. In contrast, Christie (1987) describes the economic and econometric properties of both approaches, and reaches the conclusion that return models are less likely to cause econometric problems and the choice between these two approaches should be made only on the basis of the particular research question. Kothari and Zimmerman (1995) argue that one advantage of the level approach is that the errors-in-variables problem is avoided. However, the bad news in using the levels approach is that there are potentially other econometric problems, like correlated omitted variables and heteroskedasticity (Brown, Lo and Lys, 2000 and Holthausen and Watts, 2001). In support of the valuation approach, where levels regressions are used, Rees (1997, p1113) suggests that “the valuation approach is more convenient than the more usual returns based analysis”. Taken together, these studies identify a variety of issues with both returns and levels approach. It is still not entirely clear, as a consequence, which methodology outperforms the other in capital markets-based accounting research. Nonetheless, it can be argued that levels approaches are probably more prominent currently.

It is recognized, as discussed above, that the returns approach, where (abnormal) returns are regressed on explanatory variables, is an alternative to establishing associations between accounting information and stock market returns. Empirical studies in the UK
have used this methodology to investigate the value relevance of various types of accounting information including, for instance, earnings, cash flow, funds flow, dividends, capital expenditures, and financing flows (Board, Day and Walker 1989, Ali and Pope, 1995, Clubb, 1995, Charitou and Clubb, 1999 and Garrod and Hadi, 1998, Burton and Lonie, 1999, amongst others). Their findings generally support the predicted associations between returns and these accounting information items.

2.2.2 The role of book value and equity valuation

The development of identifying the association between stock price and accounting numbers, in particular book value and its components, are motivated by the theoretical work of Ohlson (1989, 1995) and Feltham and Ohlson (1995, 1996). These studies build the foundation of a large body of value relevance literatures since they suggest that book value is associated with market value, while earnings are associated with changes in market value. Overall, their work concludes that both income statement and balance sheet data should be included in the equity valuation model. Ohlson’s valuation framework is reviewed in detail in the next section and some empirical evidence from the value relevance studies adopting this framework are discussed next.

2.2.3 Ohlson’s valuation model and the development of valuation models in the UK

The Ohlson modelling approach (Ohlson 1995 and Feltham and Ohlson 1995) is one of the most important development in capital market research in the last ten years, as Lundholm (1995, p749) states: “The Ohlson (1995) and Feltham and Ohlson (1995)
papers are landmark work in financial accounting”. One of the contributions of Ohlson models (OM) identified by Bernard (1995) is the use of these models as a point of departure for empirical work, to guide researchers in structuring the relationship between accounting data and firm value. In this section, we revisit the OM, mainly its valuation framework and empirical applications, how the OM has been developed as part of corporate valuation theory, and issues associated with implementing the Ohlson modelling framework in empirical studies.

2.2.3.1 The OM valuation framework

Ohlson (1989) and Ohlson (1995) provide a useful theoretical framework and benchmark when one conceptualizes how market relates to accounting data and other information. In this section, we will start with the assumptions of the OM; explain the valuation framework of the OM which is developed from PVED (Miller and Modigliani, 1961), where firm value or market price equals the present value of expected dividends, and “linear information dynamics (LID)” (Ohlson, 1995); discuss the modelling extension of Feltham and Ohlson (1995), and also the theoretical extensions of the OM by Stark (1997) and Ohlson (1999).

2.2.3.2 Residual income valuation

By reference to Lundholm (1995), there are three crucial assumptions in the OM. The first assumption is the equilibrium condition - the non-intertemporal arbitrage price that results when interest rates are non-stochastic, beliefs are homogeneous, and individuals
are risk-neutral. The second assumption defines the clean surplus relation as book value this year equals last year’s book value plus income minus dividends. The third and final assumption in Ohlson model is referred to as “linear information dynamics” (LID).

Lo and Lys (2000) consider the OM as Ohlson’s application of the residual income valuation model (RIV) and, moreover, Ohlson’s linear information dynamics (Ohlson, 1995) as providing additional structure to link the RIV model to testable propositions. Testing the OM, according to Lo and Lys (2000), is a joint test of RIV and Ohlson’s information dynamics.

RIV is an integral part of the Ohlson model, though RIV can be traced back as early as 1938 (Preinreich 1938, p240). It expresses the economic value of the firm as being equal to the firm’s book value of equity plus the present value of all its expected future residual income (Edwards and Bell, 1961 and Peasnell, 1982). RIV is developed from a single hypothesis: asset prices represent the present value of expected future dividends (PVED):

\[
P_t = \sum_{\tau=1}^{\infty} \frac{E_t(d_{t+\tau})}{(1+r)^\tau}
\]

(2.1)

where

\[P_t\] = market price of equity at time \(t\),

\[d_{t+\tau}\] = future dividends at time \(t + \tau\),

\[r\] = discount rate at time \(t\),

\[E_t\] = expectation operator based on the information set at time \(t\).

together with two assumptions. The first is the clean surplus relation:
\[ b_t = b_{t-1} + x_t - d_t \]  \hspace{1cm} (2.2)

where \( b_t \) = book value of equity at time \( t \),
\( d_t \) = dividends at time \( t \),
\( x_t \) = clean surplus earnings at time \( t \),

and the second is that the book value of equity grows at a rate less than \( R \):

\[ \frac{E_t(b_{t+1})}{(1+r)^t} \xrightarrow{t \to \infty} 0 \]  \hspace{1cm} (2.3)

RIV, mathematically equivalent to PVED, then follows:

\[ P_t = b_t + \sum_{\tau=1}^{\infty} \frac{E_t(x^\alpha_{t+\tau})}{(1+r)^\tau} \]  \hspace{1cm} (2.4)

where \( x^\alpha_{t+\tau} \) = future abnormal earnings at time \( t \).

As the precursor of the OM, RIV is known to be equivalent to the dividend discount model which denotes that stock prices represent the present value of expected cash flow. It is untestable, however, since the model imposes clean surplus on the accounting system, which means at least one of the two variables in the clean surplus relation, book value or earnings, may not correspond to any number that appears in the actual financial statements and, hence, “imposes data requirements that are impossible to meet in actual empirical settings” (Lo and Lys, 2000).

Though RIV has been widely acknowledged as the precursor of the OM, Ohlson (2001) argues that RIV enters his modelling process primarily because it condenses and
streamlines the mathematics. Also he insists that RIV should not be thought of as the formula necessary to derive conclusions bearing on values and earnings.

2.2.3.3 Linear information dynamics (LID)

One way to implement the model is to estimate future reported earnings and dividends. These could be used to calculate (expected) future book values which (together with reported earnings) allow the investor to predict future abnormal earnings. However, one could then question the benefits of this model because it requires estimates of accounting variables in addition to dividends. It seems that estimating dividends and employing the dividend discount model is then a more straightforward way to estimate intrinsic value.

One solution suggested by Ohlson (1989, 1995) to this dilemma is to add more structure to the model in the form of additional assumptions. Ideally, these assumptions should allow the firm’s market value to be expressed in terms of observable variables (i.e. period t variables). This additional structure is termed as Linear Information Dynamics.

In Ohlson (1995), the LID assume that abnormal earnings evolve as a simple autoregressive (AR) process:

\[
X_{t+1}^a = \omega X_t^a + V_t + \epsilon_{1,t+1} \tag{2.5}
\]

\[
V_{t+1} = \gamma V_t + \epsilon_{2,t+1} \tag{2.6}
\]

where \( \omega = \) persistence parameter for abnormal earnings (\( 0 \leq \omega \leq 1 \))
\( V_t = \) “other information” (defined in Ohlson, 1995) as “the information about future abnormal earnings which is not contained in current abnormal earnings”)

\( \gamma = \) persistence parameter for “other information” (\( 0 \leq \gamma \leq 1 \))

\( \epsilon_{1,t+1}, \epsilon_{2,t+1} = \) error term of period \( t+1 \)

When these forecasting dynamics are combined with RIV, Ohlson (1995) shows that the valuation of a firm can be expressed as a linear combination of book value, abnormal earnings and “other information”, and more importantly, he demonstrates how to derive the value of the valuation model parameters:

\[
p_t = b_t + \alpha_1 x_t^a + \alpha_2 v_t
\]

(2.7)

where

\[
\alpha_1 = \frac{\omega}{(1 + r - \omega)}
\]

(2.8)

\[
\alpha_2 = \frac{1 + r}{(1 + R - \omega)(1 + r - \gamma)}
\]

(2.9)

Dechow, Hutton and Sloan (1995) examine whether these LID represent some approximation as to how companies are actually valued on the stock market. Essentially, they estimate \( \omega \) and \( \gamma \) and use these estimates, combined with an assumed cost of capital of 12%, to produce associated estimates of stock price from equations (2.7), (2.8) and (2.9) to see how closely these estimates correspond to actual stock prices. They also evaluate different model specifications. They use using forecast error, defined as the observed stock price minus the predicted price, divided by stock price at the end of the year. A key result is that all the model specifications seriously underestimate the
price. The range is from 22.7% to 37.8% of share price, although they suggest one possible reason could be that the discount rate of 12% they assume could be too high. Another possible reason might be that the stock market overestimates company value.

An appealing characteristic of the Ohlson (1989, 1995) model is that the simple linear structure of the Ohlson (1995) model, together with the simple LID, provides a testable pricing equation that identifies the roles of accounting and non-accounting information. Nonetheless, it is extremely simplistic given that empirical evidence suggests that many more accounting variables than book value and abnormal earnings have been found to be value relevant. Further, it assumes that ‘other information’ is single dimensioned (Akbar and Stark, 2003a). As a consequence, the concept of ‘other information’ cannot be invoked to capture these other value relevant accounting variables. Once this is recognised, constructing LID to capture the complexity of the possible relationships, whilst simple from a mathematical point of view, essentially rules out the type of research approach adopted by Dechow, Hutton and Sloan (1996) in which LID systems are estimated and used to generate price estimates. This is because the data requirements for such estimates are too constraining. As a consequence, the empiricist is forced to use empirically generated valuation models.

2.2.3.4 The Feltham-Ohlson modeling extension (FOM)

Feltham and Ohlson (1995) expand the OM by separating a firm’s net assets into financial and operating assets. They divide book value into financial assets and operating assets, earnings into interest and operating income. By relabeling operating assets as book value and operating earnings as total earnings, Lo and Lys (2000) summarize that
what distinguishes FOM (Feltham and Ohlson, 1995) from the OM (Ohlson, 1995) are their information dynamics:

\[ X_{t+1} = \alpha X_t + \delta b_t + V_{1,t} + \varepsilon_{1,t+1} \]  
\[ b_{t+1} = \delta_2 b_t + V_{2,t} + \varepsilon_{2,t+1} \]  
\[ V_{1,t+1} = \gamma_1 V_{1,t} + \eta_{1,t+1} \]  
\[ V_{2,t+1} = \gamma_2 V_{2,t} + \eta_{2,t+1} \]

where \( X^{\alpha}_{t+1} \) = future abnormal earnings / residual income at time \( t+1 \).

\( b_t \) = book value of equity at time \( t \),

\( V_t \) = “other information” that is not yet reflected by accounting information, but capturing the movement of market price at time \( t \).

Lo and Lys (2000) also argue that, in spite of what is claimed by Feltham and Ohlson (1995) as “valuation for operating and financial activities”, the FOM (Feltham and Ohlson, 1995) provides an analysis of conservatism and growth since, if \( \delta_1 > 0 \), accounting is conservative; if \( \delta_1 = 0 \), it is unbiased. Meanwhile, \( \delta_2 \) parameterizes the growth in book value.

One unappealing characteristics of Ohlson and Feltham (1995) model discussed in detail in Lo and Lys (1999), Sunder (1999), Verrecchia (1998), and Holthausen and Watts (2001) is that “the accounting content is lost because the model does not offer any guidance or predictions about firms’ choice of accounting methods or properties of accounting standards, nonwithstanding the frequent use of the term conservative and unbiased accounting in the context of the residual income model”. (Kothari, 2001, p78)
2.2.3.5 Valuation of earnings components


Ohlson (1999) restated this point by partitioning clean surplus earning into transitory earnings and recurring earnings. The modelling extension in Ohlson (1999) suggests that the value relevance of an earnings component depends on their ability to predict future abnormal earnings incremental to abnormal earnings and on the persistence of the component. Pope and Wang (2000) extend the work of Stark (1997) and Ohlson (1999) to include further conditions where components of comprehensive income may or may not be value relevant. These studies set out the basis for tests of value relevance.

Many empirical researchers adjust the OM by partitioning accounting items and examining the value relevance of the partition. For example, in the UK, Rees (1997)

\[ \text{Stark (1997) shows that earnings components are valuation irrelevant if they have no ability to predict future earnings, dividend, or book value.} \]
decomposes earnings into dividends and retained earnings, and book value into total capital and total debts; Stark and Thomas (1998) disaggregate earnings into earning plus RD expenditures and RD expenditures. Barth, Hand and Landsman (1999) in the US find the differential ability of accrual and cash flow components of earnings to help predict future abnormal earnings and the persistence of the components result in the components having different valuation implications.

### 2.2.3.6 Tests of Ohlson models

Lo and Lys (2000) summarize Ohlson’s contribution to capital market research to be threefold. First, Ohlson (1995) revives the use of residual income in valuation research by proposing information dynamics linking RIV with testable propositions. Second, linear information dynamics (LID) provides a way to link the dividend discount model to observable accounting variables. Third, the model provides a framework to understand the different ad-hoc valuation approaches used in the past (for example, it helps to understand the discussion of whether earnings changes or earnings levels are appropriate in earnings-returns specifications).

“Existing empirical research has generally provided enthusiastic support for the Ohlson model.”

Dechow, Hutton and Sloan (1999, p2)

This section first discusses prior empirical studies value relevance studies in the US. Typically, whilst such studies are influenced by Ohlson (1995), they do not provide direct tests of any specific LID systems. Rather, they include both book value and
earnings and take advantage of the linear valuation structure in Ohlson’s work. The survey does not intend to be too comprehensive due to the vast amount of research papers relevant in this area. This section also surveys those research papers in the UK using a cross-sectional valuation approach to identify the value relevance of accounting information, for example, Green Stark and Thomas (1996), Stark and Thomas (1998), Citron (2001), Akbar and Stark (2003a), Dedman, Mouselli, Shen and Stark (2009) and Shah, Stark and Akbar (2009) with respect to research and development expenditures; Rees (1997), Akbar and Stark (2003a), Dedman, Mouselli, Shen and Stark (2009) and Shah, Stark and Akbar (2009) with respect to dividends, debt and investment; Garrod and Rees (1998) with respect to international diversification; Stark and Thomas (1998) with respect to residual income; Citron (2001), with respect to deferred taxation; Kallapur and Kwan (2004) with respect to brand assets; Akbar and Stark (2003a) with respect to dividends and capital contribution, and Shah, Stark and Akbar (2009) with respect to goodwill and advertising expenditures. Our discussion includes the analysis of the models employed in the above empirical studies, and a comparison of their empirical findings is presented. Discussion of the scale effect is included in the next section, using these UK papers to explain the issue of deflation.

Any test of the OM (1995) is a joint test of the three main assumptions: present value of expected dividends (PVED), clean surplus relation (CSR) and linear information dynamics (LID). (Lo and Lys, 2000). A test of the OM, ignoring the information dynamics, is equivalent to testing RIV. Ohlson (2001) restates the same point by arguing that empirical research with a close focus on the OM must try to estimate the parameters
\( \omega \) and \( \gamma \) in the information dynamics, since the model becomes too simplistic without “other information”.

The OM approach has stimulated much empirical research in the US. Some empirical work (Frankel and Lee, 1998; Lee, Myers and Swaminathan, 1999; Penman and Sougiannis, 1997, 1998; Francis, Olsson and Oswald, 2000, amongst others) refers to Ohlson (1995), ignoring the information dynamics. There are at least three attempts (Dechow, Hutton and Sloan, 1999; Myers, 1999; Hand and Landsman, 1998) testing the Ohlson model in combination with the information dynamics.

Dechow, Hutton and Sloan (1999) use analyst earnings forecasts as a proxy for non-accounting information as suggested by Ohlson (1999). They estimate both \( \omega \) (0.62) and \( \gamma \) (0.32) in the information dynamics, and the results are within the range specified by OM.

The final model estimated by Myers (1999) can be considered as a test of the OM because it explicitly attempts to incorporate non-accounting information (Lo and Lys, 2000). Myers (1999) uses book value of equity and order backlog to control for conservative accounting and proxy for “other information”. He finds that these two variables provide little improvement over estimating market value on book value alone – they either contradict theoretical predictions (book value of equity) or add noise (order backlog). Myers (1999) examines four different specifications for linear information dynamics model, and finds that these specifications under-perform book value alone in estimating equity values.
Hand and Landsman (1999) assess the empirical validity of OM by testing the sharply differing predictions that emerge in Ohlson (1995) from two assumptions about other information $V_i$ that is reflected in a firm’s equity market value but not in its current financial statements. They find that Ohlson’s information dynamics are violated since the coefficient of dividends is reliably positive when it is predicted to be negative.

Kothari (2001) summarizes that main conclusions emerged from the recent US empirical studies that compare the OM’s ability to explain cross-sectional in security prices as that the traditional implementation of the dividend-discounting model by capitalizing analysts’ forecasts of earnings is just about successful as the residual income valuation model.

Beaver (2002) suggests that the major application of the OM is in the value relevance literature. Holthausen and Watts (2001) define value relevance studies as accounting papers investigating “the empirical relationship between stock values and particular accounting numbers”. An accounting number is “value relevant” if it is significantly related to the market value. Beaver (2002) finds that papers by Ohlson (1995, 1999) also use the term “value relevance” in a manner consistent with empirical studies.

Many value relevance studies adopt the OM in the US (e.g., Barth, Beaver and Landsman, 1992, 1996, Barth, Clement, Foster and Kasznik, 1998, Amir, 1993, Aboody, Barth and Kasznik, 1999). Barth, Beaver and Landsman (1992) examine whether pension cost components’ coefficients differ from one another when determining security prices. Their major findings are that the coefficients are different, and the transition asset
amortization coefficient is lower than other pension coefficients. Barth, Beaver and Landsman (1996) investigate the value relevance of loans, securities and long-term debt for bank share prices. Barth, Clement, Foster and Kasznik (1998) use the OM, including brands as “other information”, and conclude that estimated brand values capture valuation-relevant information not reflected in book value of equity or earnings.

Amir (1993) tests predictions relating to postretirement benefit liability components and cost components. The results indicate that, given earnings and pension information, aggregated postretirement pension disclosures are value relevant, as is information on cost components. However, information on liability components has only marginal explanatory power.

A number of cross-sectional valuation analyses have been performed in the US on the value relevance of RD expenditures. Earlier studies (e.g., Hirschey, 1982, Hirschey and Weygandt, 1985, Connolly and Hirschey, 1990, Hirschey and Spencer, 1992) find a significantly positive coefficient for research and development expenditures in cross-sectional valuation models. A study by Sougiannis (1994) adopts Ohlson (1989) by employing the framework that market value can be expressed as a linear combination of book value and residual income, where he restates as net income plus the after-tax effect of research and development expenditures. He also adds advertising expenditures and current and past RD expenditures as independent variables in his estimation model. Sougiannis (1994) finds that only current RD expenditures are value relevant in most years of his study.
2.2.3.7 Development of accounting-based firm valuation models in the UK context

The discussion above concludes that the OM constitute of two components: residual income valuation and information dynamics. To fit the purpose of empirical testing, the OM (Ohlson, 1995 and Feltham and Ohlson, 1995) has been adjusted in which market value can be expressed as a linear combination of book value, what amounts to capitalized current residual income, and “other information”:

\[ MV_t = \alpha_1 BV_t + \alpha_2 RI_t + \alpha_3 OI_t + \epsilon_t \]

where \( MV_t \) is the market value of equity at time \( t \); \( BV_t \) represents book value of equity at time \( t \); \( RI_t \) is residual income at time \( t \); \( OI_t \) is “other information”.

A different version of the empirical model makes an appeal to a linear information dynamics framework involving the three variables suggested by Ohlson (1989) - clean surplus earnings, book value and dividends (net shareholder cash flows), which is employed by some empirical researchers, where market value can be expressed as the sum of contemporaneous book value, net shareholder cash flow, comprehensive income and “other” value relevant variables:

\[ MV_t = \alpha_1 BV_t + \alpha_2 NSCF_t + \alpha_3 E_t + \alpha_4 OI_t + \epsilon_t \]

where additionally, \( NSCF_t \) is net shareholder cash flow at time \( t \); \( E_t \) is comprehensive earnings at time \( t \).
As discussed briefly in the previous section of research background, a contested literature on value relevance suggests that the value relevance of earnings has been decreasing over time (Schipper and Francis, 1999, Collins, Maydew and Weiss, 1997, Lev and Zarowin, 1999, etc.), while the value relevance of book value has been increasing. Nonetheless, results are mixed on whether the increase in the relevance of book value has offset the decrease observed in earnings. Accounting conservatism is posited as one possible reason for the observed decrease in the value relevance of book value and earnings. The presumption behind this explanation is that value relevance decreases with conservatism, and, for example, it has been recognized in literature that practices such as expensing RD are so conservative that “Accounting is no longer counting what counts” (Stern and Stewart, 2002). Further, it is argued that RD has become more important to firms and, as a consequence, RD spending has increased over time. Hence, it is logical to include RD in the valuation framework as an earnings component to increase the overall value relevance of these models.

Green, Stark and Thomas (1996) provide empirical evidence suggesting that RD expenditures are value relevant in the UK stock market. The model they estimate is presented as follows:

\[ MV_t = \alpha_0 + \alpha_1 BV_t + \alpha_2 RI_t + \alpha_3 RD_t + \sum_{j=1}^{6} \lambda_j Z_{jt} + \epsilon_t \]  

(2.14)

where \( RD_t \) = research and development expenditures

\( Z_{jt} \) = control variables
This model fits into the framework of OM1. As Ohlson (1995) defines “other information” as other value relevance information that helps predict accounting information, but cannot be directly derived from it, RD estimated in Green, Stark and Thomas (1996) is not “other information”, strictly speaking. RD is included as intangible assets since Green, Stark and Thomas (1996) also base their model on Hirschey (1982) and Hirschey and Weygandt (1985), which indicates that market value is expressed as the sum of market values of intangible assets and tangible assets. Green, Stark and Thomas (1996) estimate their model with RD expenditures for another reason. According to Chauvin and Hirschey (1993), data on RD expenditures appear to help investors from appropriate expectations concerning the size and variability of future cash flows. RD can be viewed as a form of investment in intangible assets with positive predictably positive effects on future cash flows.

It is also worth noting that Green, Stark and Thomas (1996) add a number of control variables $Z_{it}$ to the estimation model. These control variables are those that have been proposed value relevant in previous studies, and the role of their presence is to “make tighter inferences about the coefficients of particular interest in this study” (Green, Stark and Thomas, 1996). The control variables measure market share, industry concentration, firm gearing, industry gearing, the squared difference between firm and industry gearing, and equity returns variance.

Though Green, Stark and Thomas (1996) find no statistically significant impact of these control variables on the explanatory power of the model and other variables, the significance of control variables is related to the problem of omission of variables.
Taking firm gearing as an example, if firm gearing, as a control variable, is correlated with an independent variable (for instance, E), the regression model estimates for E will be biased so that hypothesis testing becomes unreliable. As long as the correlation between any of the variables and industry gearing is not zero, the omission of industry gearing as a control variable will bias the coefficients of other remaining variables.

Rees (1997) innovates by partitioning earnings into the proportion of earnings distributed as dividends and that retained. Despite the dividend and capital structure irrelevance theories of Modigliani and Miller (1961), it is now widely accepted that outwith the idealised environment of the Modigliani and Miller analysis, these decisions may have relevance to firm value (Rees, 1997). Rees (1997) further explains his motivation for including dividends in the valuation framework by arguing that analysts’ forecasts create a proxy for expected abnormal income in residual income valuation (e.g., Frankel and Lee, 1996a and 1996b) and, hence, “if analysts look beyond earnings and the book value of equity to assess the worth of a firm they may search for indicators of quality. There is theoretical and empirical work which suggests that this search could include consideration of financial management decisions concerning dividend payout, debt levels, or capital expenditure.” (Rees, 1997, p1111) It is clear that the inclusion of dividends in an empirical valuation model is potentially in direct contrast to the assumption of dividend irrelevance built into Ohlson’s work. Nonetheless, empirical work in both the UK and the US tends to reject dividend irrelevance (e.g., Rees, 1997, Akbar and Stark, 2003a, Hand and Landsman, 2005 and Dedman, Mouselli, Shen and Stark, 2009).
Rees (1997) builds up his valuation model upon a basic model:

\[ MV_t = \alpha_0 + \alpha_1 BV_t + \alpha_2 E_t + \epsilon_t \]  

In order to test three key financial variables that are believed to be potential value indicators, Rees (1997) extends the basic model. Earnings are decomposed into ordinary dividends and retained earnings to examine dividend relevance; book value of equity is restated as total capital (book value of equity plus total debt) less total debt to test debt relevance; and capital investment is included in the estimation model since previous studies indicate a signalling effect for investment expenditures. The basic model above is then transformed into:

\[ MV_t = \alpha_0 + \alpha_1 (BV_t + TD_t) - \alpha_2 TD_t + \alpha_3 RE_t + \alpha_4 D_t + \alpha_5 IV_t + \epsilon_t \]  

where additionally

- \( RE_t \) = retained earnings at time \( t \),
- \( D_t \) = dividends at time \( t \),
- \( TD_t \) = total debts at time \( t \), and
- \( IV_t \) = capital investment at time \( t \).

The Rees (1997) model may not be a fair extended version of the OM since it ignores NSCF from OM2. Meanwhile, \( IV \) may be treated as “other information” since investment expenditure can be used to capture accounting information.

Stark and Thomas (1998) examine the value relevance of residual income in the valuation process, which naturally relates their estimation model with OM1:
\[ MV_t = \alpha_0 + \alpha_1 BV_t + \alpha_2 (E_t - kBV_{t-1}) + \epsilon_t \] (2.17)

Stark and Thomas (1998) denote residual income using the following equation:

\[ RI_t = E_t - kBV_{t-1} \] (2.18)

where 
- \( RI_t \) = residual income at time \( t \),
- \( BV_{t-1} \) = opening book value at time \( t \),
- \( k \) = cost of capital.

Replacing \( RI_t \) in OM1 with equation (2.18), we get the equation (2.17). Stark and Thomas (1998) estimate the rearranged version of model (2.17) above. Additionally, they partition earnings into RD expenditures and earnings plus RD expenditures, which has been shown in Green, Stark and Thomas (1996) to improve the ability of the model to explain market value. However, Stark and Thomas (1998) do not include any other value-relevant variables in their model, which means “other information” is absent from their estimation. Hence, the final model they employ for estimation is as follows:

\[ MV_t = \alpha_0 + \alpha_1 BV_t + \alpha_2 (E_t + RD_t) + \alpha_3 RD_t + \alpha_4 BV_{t-1} + \epsilon \] (2.19)

Strictly speaking, Stark and Thomas (1998) is not an empirical study of the OM since it ignores the most important characteristic of linear information dynamics and fails to include “other information” in their estimation model, though the model they employ is still based on the framework of OM1.
Garrod and Rees (1998) investigates the value relevance of international diversification of UK firms by estimating whether or not foreign earnings and assets are more highly valued than their domestic equivalents. They adopt the basic model of Rees (1997).

Due to the fact that a company that has a significant net assets, sales or profits outside the UK is required to disclose these figures in the accounts, Garrod and Rees (1998) extend the above basic model by segmenting BV into its net assets and net assets adjustment largely consisting of debt financing; also decomposing E into profit before taxation plus profit adjustment including taxation, exceptional items and minority interests:

$$MV_i = \alpha_0 + \alpha_1 NA_{adj}_i + \alpha_2 PT_{adj}_i + \alpha_3 NA_i + \alpha_4 PT_i + \epsilon_i$$

(2.20)

where

- $NA_t = \text{net assets at time } t$,
- $PT_t = \text{profits before taxation at time } t$,
- $NA_{adj}_t = \text{net assets adjustment} = BV_t - NA_t$,
- $PT_{adj}_t = \text{profits adjustment} = E_t - PT_t$.

Garrod and Rees (1998) explains this adjustment of the basic model as “necessary for the completeness of the model but do not play a part in our subsequent testing”. Ironically, on the contrary, their estimation model is “incomplete” as an empirical model based on Ohlson model since it omits either $RI$ from OM1 or $NSCF$ from OM2, not mentioning the absence of “other information”.

A further decomposition is made to their estimation model to serve their hypothesis testing concerning whether there are any valuation difference between net assets and
profits of domestic and multinational firms. For multinational firms especially, their net assets are disaggregated into net assets in the UK and those overseas, as are profits. The extended model is as follows:

\[ MV_i = \alpha_0 + \alpha_1 NAadj_i + \alpha_2 PTadj_i + \alpha_3 D, UKNA_i + \alpha_4 D, UKPT_i + \alpha_5 M, UKNA_i + \alpha_6 M, UKPT_i + \alpha_7 OSNA_i + \alpha_8 OSPT_i + \alpha_9 OTNA_i + \alpha_{10} OTPT_i + \varepsilon_i \]  

(2.21)

where \( D \) denotes domestic firms, and \( M \) is for multinational companies; UK represents that the assets or profits are held or generated in the UK, while \( OS \) stands for overseas; additionally, \( OTNA_i \) is the balancing figure between total segmental and consolidating assets, and \( OTPT_i \) is the balancing figure between total segmental and consolidated profits.

Garrod and Rees (1998) believe that significant differences are expected between coefficients of UK assets or profits of domestic firms and their multinational counterparts - if international diversification does have an important impact on valuation. Following the same logic, Garrod and Rees (1998) further refine their model according to geographical differences to investigate if there are any difference in the valuation of assets and profits from UK companies and their equivalents in continental Europe, the Americas and the rest of the world. Garrod and Rees (1998) do not provide an empirical test of the OM, as such. They pioneer in a novel way the use of valuation models to study the value relevance of internationalization.
Citron (2001) starts with the basic model of Rees (1997) and Garrod and Rees (1998). He restates the book value of equity into its assets and liabilities and enables them to take different coefficients in the model:

\[ MV_t = \alpha_0 + \alpha_1 Assets_t + \alpha_2 Liabs_t + \alpha_3 E_t + \epsilon \quad (2.22) \]

where \( Assets_t \) is the assets at time \( t \), \( Liabs_t \) is the liabilities at time \( t \).

Furthermore, Citron (2001) then includes opening book value \( BV_{t,1} \) in the model. However, opening book value is replaced with opening assets due, in the estimation model, to the high correlation between liabilities and opening book value (correlation coefficients = 0.81). Citron (2001) explains why he does not adopt the partition of earnings into retained earnings and dividends (Rees 1997) with two reasons. One is that the taxation focus of his paper makes a pre-tax measure of earnings preferable. The other is that dividends are not supposed to be included in the model together with opening book value due to the clean surplus relation.

Given the major purpose of Citron (2001), the value relevance of taxation items, two separate variables are included in the model to capture the valuation effect of deferred taxation. Hence, the main model Citron (2001) used for estimation is as follows:

\[ MV_t = \alpha_0 + \alpha_1 Assets_t + \alpha_2 Liabs_t + \alpha_3 E_t + \alpha_4 DT Prov_t + \alpha_5 DT Note_t + \epsilon \quad (2.23) \]

where \( DT Prov_t \) is the partial deferred tax; and \( DT Note_t \) is the potential portion deferred tax liability which is disclosed only in the notes of the accounts.
Citron (2001) does not include RD expenditures, which is suggested as positively related to market value in both Green, Stark and Thomas (1996) and Stark and Thomas (1998). Hence, his model is “incomplete” in the sense of the omission of some value relevant variables, which may cause problem such as lack of power in hypothesis testing if the omitted variable is uncorrelated with the existing variables, or omission of a correlated omitted variable will potentially bias coefficients of the variables contained in the model.

Kallapur and Kwan (2004) adopt the simplest model so far although they claim that the model is also “consistent with the model developed by Ohlson (1995)”. The model they employ is:

\[
MV_i = \alpha_0 + \alpha_1 BV_i + \alpha_3 E_i + \alpha_4 Brand_i + YRDUM + \epsilon
\]  

(2.24)

where \(Brand_i\) denotes brand assets, with \(BV_i\) representing book value of equity excluding brand assets and \(YRDUM\) are the year dummies to control for fixed-year effects.

We conclude that the model above has problem of omitting either RI from OM1 or NSCF from OM2, although \(Brand_i\) may be considered as “other information”. Hence it does not provide a true empirical model based on Ohlson framework.

Akbar and Stark (2003a) serves as a reconciliation of the potential clash between Rees (1997) and Stark and Thomas (1998), since Rees (1997) finds that dividends are positively related to market value, whereas Stark and Thomas (1998) concludes that net
shareholder cash flows (dividends less capital contributions) have a negative impact on market values.\(^3\) Akbar and Stark (2003a) estimate valuation models that first utilize net shareholder cash flows, and then split it into dividends, and capital contributions. The first model resembles OM2 mentioned at the beginning of this section:

\[
MV_t = \alpha_0 + \alpha_1 BV_t + \alpha_2 D_t + \alpha_3 CC_t + \alpha_4 E_t + \alpha_5 RD_t + \varepsilon
\]  

(2.25)

where \(CC_t\) denotes capital contribution at time \(t\);

As Rees (1997) fails to include \(CC_t\) as a separate variable in his estimation model, a central issue for Akbar and Stark (2003a) is enabling \(D_t\) and \(CC_t\) to have separate roles in their estimation model. Meanwhile, consistent with the evidence provided in Stark and Thomas (1998) that the partition of earnings into RD expenditures and Earnings plus RD expenditures improves the value relevance of the model, Akbar and Stark (2003) include \(E_t\) (earnings plus research and development expenditures) and \(RD_t\) as two separate variables. Also, Stark and Thomas (1998) deflate their model with closing book value, while Rees (1997) uses number of shares as the deflator which causes Akbar and Stark (2003a) to investigate the influence of different deflators upon the value relevance of \(NSCF\) and its components \(D\) and \(CC\). The problem of deflators will be discussed later in this section.

\(^3\) If market value can be expressed as the linear combination of clean surplus earnings, closed book value and net shareholders cash flows: \(MV_t = E_t + BV_t + NSCF_t\), then replace NSCF\(_t\) with clean surplus relationship: \(NSCF_t = BV_t - BV_{t-1} + E_t\), we get the equation that market value is the linear combination of clean surplus earnings, opening and closed book value: \(MV_t = E_t + BV_t + BV_{t-1}\). The coefficients of opening book value \(BV_{t-1}\) will be the same as the coefficient of \(NSCF_t\). (Ohlson, 1989 and Stark and Thomas, 1998)
The cross-sectional valuation model employed in Shah, Stark and Akbar (2009) is an extension of that found in Akbar and Stark (2003a), which makes it more consistent with OM2 since besides the fact both Akbar and Stark (2003a) and Shah, Stark and Akbar (2009) is derived from the Ohlson framework of linear information dynamics, Shah, Stark and Akbar (2009) include “other information” such as ACNeilsen MEAL estimates of major media advertising expenditures in their estimation model. The model estimated is as follows:

\[ MV_t = \alpha_0 + \alpha_1 A_t + \alpha_2 GW_t + \alpha_3 RD_t + \alpha_4 E_t + \alpha_5 BV_t + \alpha_6 D_t + \alpha_7 CC_t + \epsilon \]  

where \( A_t \) = advertising expenditures at time \( t \);  
\( GW_t \) = good will on acquisition at time \( t \).

We could consider all these papers discussed so far as two different approaches of tests of the OM, one that ignores the information dynamics, which is equivalent to testing the residual income valuation model, and the other that tests the information dynamics together with the model’s predictions. Hence the model estimated by Shah, Stark and Akbar (2009) can be considered to be a test of the OM because it explicitly attempts to incorporate non-accounting information, “other information” in OM.

Table 2.1 summarizes the results of the above cross-sectional value relevance studies in the UK. The results of Green, Stark and Thomas (1996) empirically test the role residual income plays in the valuation process, consistent with Ohlson (1995) and Feltham and Ohlson (1995). However, their testing results fail to show evidence of the value relevance of RD expenditures due to “the lack of a consistent pattern of statistical
significance of the coefficients”. Nonetheless, the decomposition of earnings into RD expenditures and earnings plus RD expenditures is significant in the sense of improving value relevance in Stark and Thomas (1998). Akbar and Stark (2003a), Dedman, Mouselli, Shen and Stark (2009) and Shah, Stark and Akbar (2009) restate the same point. Another partition that improves the value relevance of the model is the decomposition of net shareholder cash flow into dividends and capital contributions. (Akbar and Stark, 2003a, Dedman, Mouselli, Shen and Stark, 2009 and Shah, Stark and Akbar, 2009).
### Table 2.1
Summary of UK Value Relevance Studies

<table>
<thead>
<tr>
<th>Papers</th>
<th>E</th>
<th>BV</th>
<th>CI</th>
<th>RI</th>
<th>RD</th>
<th>NSCF</th>
<th>Intl Div.</th>
<th>Brand</th>
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<td>Garrod and Rees (1998)</td>
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<td>Akbar and Stark (2003a)</td>
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<td>Dedman, Mouselli, Shen and Stark (2009)</td>
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<tr>
<td>Shah, Stark and Akbar (2009)</td>
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Note: E represents earnings; BV is book value of equity; D is dividends; CI is capital investment/capital expenditures; RI is residual income; RD is research and development expenditures; NSCF is net shareholder cashflow; Intl Div. is international diversification; Brand is brand assets; GW is goodwill; A is advertising expenditures; RE is retained earnings; CBV is closing book value; OBV is opening book value; DT Prov. is provisional deferred taxation; DT Note is deferred taxation only appearing in the account note. √ represents that the variable is value-relevant, while χ means it is not.
In Rees (1997), as the statistical results of pooling data show that the coefficient of dividends (12.67) is about three times that of retained earnings (4.04), which indicates that earnings distributed as dividends have a bigger impact on value than does earnings retained within the firm, the partition of earnings into dividends and retained earnings improves the value relevance of earnings. As for the coefficients of the two components of book value of equity: total capital and total debt, the values show no significant difference, which suggests the partition is insignificant. Capital investment is found to have a positive relationship with market value.

Stark and Thomas (1998) also suggest that the linear combination of residual income, RD expenditures and opening and closing book value provides a stronger association with market values than that excluding opening book value. Therefore, it indicates the important role of opening book value in the valuation process of market equity over and above its role through residual income.

Garrod and Rees (1998) fail to prove that international diversification is value relevant nor does Citron (2001) regarding partial deferred tax and the potential portion deferred tax liability which is disclosed only in the notes of the accounts. Though Kallapur and Kwan (2004) have many problems with their model estimation and research design, the main variable they investigate, brand assets, are shown to be significant.

In the UK, using cross-sectional approach, the accounting variables that have been found value-relevant are still mainly the three integral accounting items of linear information dynamics proposed in Ohlson (1989), i.e., clean surplus earnings, book value of equity
and dividends, as well as their partitioning components. “Other information” has been demonstrated to have a link with market value (Akbar and Stark 2003a). For example, Shah, Stark and Akbar (2009) find the coefficients of estimates of major media advertising expenditure are significantly associated with market value in primarily for large non-manufacturing firms (Shah, Stark and Akbar 2009).

2.2.3.8 Other information

Another important feature of the LIDU-based models is the incorporation of “other information” (Ohlson, 2001). In the US, “other information” is modelled by including consensus earnings forecasts in the valuation model as a proxy, which can cause a large shrinkage in sample size. Akbar and Stark (2003a) further argue about the unavailability of the consensus analyst forecast data in the UK, and, hence, develop an alternative proxy for “other information”. Consistent with Ohlson (2001), their proxy is built on the assumption that “other information” is single-dimensional. Akbar and Stark (2003a) use previous period’s “other information”, $OI_{t-1}$, as a predictor of unobservable $OI_t$.

To estimate $OI_{t-1}$, we start with the LID implication:

$$MV_{t-1} = \alpha_0 + \sum \alpha_i AV_{t-1} + \alpha_2 OI_{t-1}$$  \hspace{1cm} (2.27)

$LID$ suggests $E(RI_{t+1}) = \omega RI_t + \gamma OI_t$, i.e., to estimate “other information”, we need to estimate next period’s expected residual income $E(RI_{t+1})$. Ohlson (2001) assumes that $E(RI_{t+1})$ can be treated as observable and can be derived from the consensus earnings forecast:

$$E(RI_{t+1}) = E(E_{t+1}) - kBV_t$$, where $E(E_{t+1})$ is the consensus earnings forecast.
where, $MV_{t-1}$ is firm value for period $t-1$; $AV_{it}$ is a vector of value-relevant accounting variables for period $t-1$; and $OI_{t-1}$ is “other information” for period $t-1$.

Equation (2.27) can be restated as

$$\alpha_2 OI_{t-1} = MV_{t-1} - \alpha_0 - \sum \alpha_i AV_{it-1}$$  \hspace{1cm} (2.28)

which indicates that we can obtain $\alpha_2 OI_{t-1}$, a multiple of $OI_{t-1}$, if we can estimate $\alpha_0$ and the $\alpha_i$. We can approximate these coefficients by running the following cross-sectional regression:

$$MV_{t-1} = \alpha_0 + \sum \alpha_i AV_{it-1} + \epsilon_{t-1}$$  \hspace{1cm} (2.29)

and, for each firm, we can proxy $\alpha_2 OI_{t-1}$ by $\epsilon_{t-1}$.

As a consequence, for year $t$, $\alpha_2 OI_{t-1}$ is then included in the cross-sectional regression as a proxy for $OI_t$, which is consistent with linear information dynamics (LID), as shown in the equation below:

$$MV_t = \alpha_0 + \sum \alpha_i AV_{it} + \beta_1 (\alpha_2 OI_{t-1})$$  \hspace{1cm} (2.30)

Akbar and Stark (2003a) observe a consistent impact of the addition of “other information” in their estimations. In particular, the coefficient of their proxy for other information is always significant. Further, its addition into the estimated equations
results in the coefficient of earnings decreasing and the coefficients of book value and capital contributions increasing. My proposed research will consider the effects of “other information”, and further details will be discussed in the following section on research methods.

2.2.3.9 Evaluation of the implementation of the OM

As discussed above, the Ohlson model has been modified into many versions for the purpose of empirical studies. Some reform the model to deal with “dirty surplus” accounting; and some ignore certain assumptions of the model, for instance, inclusion of “other information” in the valuation framework. Another implementation issue that arises, as discussed in Choi, O’Hanlon and Pope (2006), is ignoring the intercept terms in the DHS-style implementation of the Ohlson model. Therefore, it becomes an interesting issue to evaluate the different versions of accounting-based firm valuation models. This thesis aims to contribute to existing literature by using out-of-sample valuation errors and portfolio analysis to evaluate firm valuation models.

2.3 Evaluation of firm valuation models using out-of-sample valuation errors

The relationship between equity value and accounting information is one of the most widely researched topics in accounting. An accounting amount is determined as value relevant if it has a predicted association with equity market values. Value relevance studies examine the association between accounting amounts and equity market values.

Part of this section is taken from Jiang and Shen (2009), our discussion of Barth and Clinch (2009).
through empirical implementations of existing valuation models. As summarized in (Barth, Beaver and Landsman, 2001) some value relevance studies test whether the estimated coefficient on the accounting amount being studied differs from those on other amounts recognized in financial statements (e.g., Barth, Clement, Foster and Kasznik, 1998, Barth, Beaver and Landsman, 1998, Aboody, Barth and Kasznik, 1999). Some test whether the coefficient on an accounting amount differs from its theoretical coefficient based on a valuation model (e.g., Landsman, 1986, Barth, Beaver and Landsman, 1992). Others test specific predictions relating to the magnitude of coefficients derived from a model of relevance and reliability (e.g., Barth, 1991, Choi, O’Hanlon and Pope, 2006).

Most value relevance studies draw inferences on the coefficients derived from valuation models, and one of the econometric issues that otherwise could limit the inferences and therefore, has been widely addressed in these studies, is the effects of scale. Barth and Clinch (2009) suggest that concerns with ‘scale effects’ represent a broad distrust that reflects a variety of potential econometric problems in cross-sectional accounting research.

### 2.3.1 Definition of scale and the scale effect

Since the 1980’s, the ‘levels approach’ that uses variables measured at a firm level or as *per* share values has been widely adopted in capital markets research.\(^6\) For studies using

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\(^6\) The ‘levels approach’ refers to regressing stock price levels directly on accounting variables that are also measured in levels, in contrast to a ‘returns approach’ that refers to regressing stock returns on deflated, and deflated changes in, accounting variables.
firm level data, the magnitudes of the dependent variables depend largely, but not entirely, on the scale of the observation, where scale is simply referred to as the size of an observation. In short, large (small) firms tend to have large (small) values of many variables, such as market value, earnings and book value of equity, etc. Scale is usually not of direct interest to researchers. However, the influence of scale in regressions can lead to a number of econometric problems, including coefficient bias, $R^2$ bias, and heteroscedasticity. These issues have been described as “scale effects” in market-based accounting research.

A stream of literature discusses the potential effects of scale on inferences and various approaches to mitigate the effect of scale on cross-sectional regression, but yet there is no unanimous agreement on the definition of scale and, as a result, some studies offer conflicting suggestions for mitigating ‘scale effects’. Examples of such studies include Barth and Kallapur (1996), Easton (1998), Brown, Lo and Lys (1999), Lo and Lys (2000), Easton and Sommers (2003), Barth and Clinch (2009), and Lo (2004).

Barth and Kallapur (1996) define ‘scale’ as the ‘amount originally invested in the firm’, while Easton and Sommers (2003) argue that market capitalization is, fundamentally, the definition of ‘scale’. Barth and Clinch (2009) suggest that diagnosing and mitigating scale effects requires specifying how scale might cause inference problems in the context of a particular research question. They identify in their study that ‘scale effects’ can exist in different forms, including correlated omitted scale variables, scale-varying valuation parameters and scale-related heteroscedasticity.
The lack of agreement over the definition of ‘scale’ and what constitutes ‘scale effects’ is reflected in the differing treatment of these issues in prior research. In the context of observing that large firms dominate coefficient estimates in valuation models, Easton and Sommers (2003) argue that market capitalization is, fundamentally, the definition of ‘scale’, and they suggest that deflating valuation models by market value (i.e., the dependent variable) is the best way to estimate the regression coefficients. In contrast, Barth and Kallapur (1996), using simulated accounting data to examine the effects of various scale proxies, indicate that the use of OLS techniques, combined with heteroscedasticity-adjusted estimates of coefficient standard errors, are more effective than deflation at mitigating the coefficient bias and heteroscedasticity resulting from scale differences.

Barth and Clinch (2009) investigate the effect of scale in the context of the Ohlson (1995) model, which expresses market value as a linear combination of book value and earnings, and they investigate the effects of various estimation approaches. They investigate the effects of various estimation approaches (for example, deflating with number of shares (i.e., regress with share price as the dependent variable), book value of equity (i.e., regress with market-to-book ratio as the dependent variable), and opening market value (i.e., regress with returns as the dependent variable)). Barth and Clinch (2009), following most prior studies on scale and scale effects, use the efficiency of the estimated regression coefficients and the explanatory power $R^2$ as the measure of the effectiveness of different estimation specifications in mitigating various forms of scale effects.
2.3.2 Deflator choice

One common approach to mitigate scale-related econometric problems is to deflate the equation with a size-proxy – scale factor, while, there are a few choices of deflators. Easton (1998) suggests that closing book value is a suitable deflator, while Barth and Clinch (2009) argue that Easton (1998) does not demonstrate that deflating by book value produces superior results and that part of the estimation problem constitutes the omission of size-related variables from the simple regression of market value on earnings and book value. They attempt to eradicate this problem by adding in net shareholder cash flows (that is, dividends less capital contributions) to the valuation model (as would be suggested by Ohlson, 1989). Lo and Lys (2000) argue that opening market value is the best deflator on a theoretical basis, and also that its use produces a ‘theoretically’ more appealing coefficient for dividends (that is, one that is negative) in a regression of market value on earnings, book value, dividends and capital contributions.

Easton and Sommers (2003) argue, on both practical and conceptual grounds, that closing market value (i.e., the dependent variable in many value relevance studies) is the most appropriate deflator. The practical argument underlying their argument is the observation that, in the USA, large firms dominate the parameter estimates that emerge in value relevance studies. Akbar and Stark (2003b) apply the Easton and Sommers (2003) style of analysis to UK data. They also consider the use of closing market value as a deflator. They identify five different deflators previously employed in cross-sectional valuation models as proxies for scale – (i) sales; (ii) number of shares; (iii) opening market value; (iv) closing book value; and (v) closing market value - and examine whether any of the deflators appear superior in ameliorating the influence of
large firms. They conclude that there is nothing to suggest the clear superiority of any of these deflators as a way of reducing the Easton and Sommers (2003) definition of ‘scale effects’ for UK data.

Lo (2004) evaluates two potential solutions to the ‘scale effect’ using data simulations and shows that deflation is superior to an alternative that includes a scale proxy as an independent variable. He employs total assets, sales, book value of equity, net income, number of shares outstanding and share prices as proxies for the unknown ‘true scale factor’, and examines the effects of these various scale proxies using simulated accounting data. His findings indicate that the use of OLS techniques, combined with heteroscedasticity-adjusted estimates of coefficient standard errors, are more effective than deflation at mitigating coefficient bias and heteroscedasticity resulting from scale differences.

Nonetheless, our study intends to further the exploration of this issue, by using out-of-sample percentage valuation error metrics as an alternative approach to examine the effectiveness of different deflators in cross-sectional valuation models.

2.3.3 Alternative methods to investigate the scale effect

The Ohlson (1995) model, and the underlying framework of linear information dynamics, where market value can be expressed as a linear combination of value-relevant
accounting variables, provides empirical researchers with a testable pricing equation. One version of the Ohlson model that is most widely employed is where market value is expressed as a linear function of book value of equity and earnings. Barth and Clinch (2009) argue that many studies focus on this basic model because the two variables - earnings and equity book value - are the primary variables of interest in many studies.

Following the modelling framework of Ohlson (1995), more variables than earnings and book value are included in the regression model, for instance, Barth and Clinch (2009) investigating scale effect, include additional variables – dividends and ‘other information’ – to simulate the effects of size-related omitted variables. Therefore, their basic regression model is explicitly set in a context in which correlated omitted variables can be an issue, although the extent of such variables in the simulations is limited.

Is there existing empirical evidence of the value relevance of other variables that are likely to be size-related? As pointed above, in the UK, such value relevant variables include research and development expenditures (Green, Stark and Thomas, 1996, Stark

7 Ohlson’s modelling framework is reviewed in detail in section 2.2.3 above.
8 This would not be in the case in the UK, however, where empiricists have been more concerned with the value relevance of other accounting items.
9 Although the empirical model is often claimed to be derived from Ohlson (1995), it actually lacks a clear theoretical underpinning. Ohlson (1995) makes it plain that either net shareholder cash flows or opening book value (through the residual income definition) should be in the model, potentially, together with ‘other information’.
10 Further, Ohlson (1995) does not explicitly analyse the valuation roles that could be played by the components of earnings or book value, often the focus of value relevance studies, although linear information dynamics can be easily extended to include such components and the linearity of the theoretical valuation model is maintained (e.g., Stark, 1997; Ohlson, 1999; and Pope and Wang, 2005).
11 Some of the discussion in this section and those following is based upon Jiang and Shen (2009).
and Thomas, 1998, Citron, 2001, Akbar and Stark, 2003a, Dedman, Mouselli, Shen and Stark, 2009 and Shah, Stark and Akbar, 2009), for some firms at least, major media advertising expenditures (Shah, Stark and Akbar, 2009), dividends (Rees, 1997, Akbar and Stark, 2003a, Dedman, Mouselli, Shen and Stark, 2009 and Shah, Stark and Akbar, 2009), capital contributions (Akbar and Stark 2003a, Dedman, Mouselli, Shen and Stark, 2009, and Shah, Stark and Akbar, 2009), and capital expenditures (Rees, 1997 and Dedman, Mouselli, Shen and Stark, 2009). Similar results can be found in the USA for some or all of the variables mentioned above. In the UK at least, the value relevance of these variables is robust to the inclusion of proxies for ‘other information’ (Akbar and Stark 2003a and Dedman, Mouselli, Shen and Stark, 2009).

Other value relevant variables, such as advertising expenditures and information on deferred taxes, have not been considered for inclusion in the valuation model tested in this study, despite some UK evidence on the value relevance on these items, due to data availability problems or data collection costs. For instance, deferred taxation data is manually collected (Citron, 2001) and advertising expenditures data (Shah, Stark and Akbar, 2009) requires acquiring a costly special database, ACNielsen Neal. Due to time and resource constraints, we have not included these variables in the valuation model.

The evidence above on the value relevance of other variables raises two issues. First, even if the independent variables of interest are indeed earnings and book value, and even if we do not know whether the omitted variables are correlated with earnings and book value or not, would not one way to control for the effects of omitted variables be to include them in the valuation model? This would also, presumably, produce tighter
inferences on the variables of interest. It is then reasonable to ask if the conclusions about the best performing estimation techniques would hold for such an expanded model, given that they could be influenced by the use of a basic regression model and the specific correlation structure for omitted variables.

Second, the empirical correlation structure between earnings, book value, and other value relevant variables might be complex. This puts strain on the ability of the simulated samples, using a simplified underlying valuation model, to reasonably replicate the correlations between value relevant variables present in the actual data. Again, if different correlation structures have the potential to affect the conclusions about best performing estimation techniques, the generality of the conclusions reached by BC might be open to question.

Our study, therefore, compares a benchmark model of market value regressing on book value and earnings against an extended firm valuation model, built on Rees (1997) and Akbar and Stark (2003a), where corporate value is modelled as a linear function of accounting variables found to be associated with company value in the UK (book value, earnings, research and development expenditures, dividends, capital contributions and capital expenditures).

Another important feature of linear information dynamics based model is the incorporation of ‘other information’ (Ohlson, 2001) in the valuation equation. The definition of, and prediction procedure for, “Other Information” are discussed in section 2.2.3.8.
2.3.4 Alternative metrics to investigate the scale effect

2.3.4.1 Limitations of the simulation approach

Barth and Clinch (2009) raise a number of important issues with respect to solving econometric issues endemic to much capital markets research. Their methodology of using the simulated data to draw conclusions about optimal estimation approaches is open to discussion, however. For example, as their data is designed to mimic characteristics of US data, two questions can be asked. First, how well do they replicate US data? Second, even if they do replicate US data appropriately, how generalizable are their results to other countries which might have other data characteristics? Is there any prior evidence, direct or indirect, on this latter issue? Nonetheless, if simulation techniques are not used to evaluate estimation approaches, what other approaches are possible? Put another way, what are the pro’s and con’s of using simulation approaches and what are the alternatives?

2.3.4.2 Advantages and disadvantages of simulation approaches

Barth and Kallapur (1996) and Barth and Clinch (2009) are two papers in the literature that adopt simulation methods for investigating scale effects. Simulation techniques have come to be used for understanding the properties of complicated estimators in econometrics research with increases in computing power and the sophistication of econometrics software. Nonetheless, they are relatively rare in accounting research. One advantage of using simulations is that the researcher can ‘know’ the coefficients for a regression by specifying the ‘true’ model used to generate the simulated data. As a consequence, coefficient bias can be directly tested for. Further, the power of
conventional statistical tests can be investigated. Another advantage is that, when it is not mathematically feasible to demonstrate the properties of the estimators, simulations can provide insights into these properties. For example, Barth and Clinch (2009) argue that they use simulated data because the scale effects they analyze take on complicated functional forms, implying that a direct mathematical analysis of the properties of estimators is infeasible.

There are disadvantages for simulations, however. In particular, the issue of the generality of conclusions drawn from simulations raises one such disadvantage. Presumably, generality is affected by the extent to which key properties of real world data are successfully mimicked. If key properties are not successfully mimicked then the conclusions might have limited generality. Further, what are the key properties?

The simulations in Barth and Clinch (2009) employ a valuation model of the firm that includes earnings, book value, and can include other variables such as dividends and ‘other information’, depending upon the nature of the scale effects simulated. Barth and Clinch (2009) calibrate their valuation model to produce sample observations that have similar cross-sectional distributions for market value, book value, and earnings to US firms. Nonetheless, Barth and Clinch (2009) do not report on whether other characteristics of the simulated data mimic actual US data.

As an example, it is also not clear that the simulations will be successful in replicating some ‘extreme’ firms that are present in the US (and elsewhere). Take biotechnology firms, for example. Some of them make losses, have low sales, small book values, but
high market values. Such firms may be extreme as market value appears to be high relative to accounting fundamentals. Also, biotechnology firms can stay in business for a long time, although frequently making accounting losses, by living on investments from large pharmaceutical firms or other institutions. For firms with negative earnings, the Ohlson (1995) linear information dynamics underlying Barth and Clinch (2009)’s simulations might seem inappropriate, because accounting losses are a poor signal of future earnings and future prospects in general.

As a second example, the correlation structure built into the simulated data (e.g., between the dependent and independent variables, between the independent variables and any omitted variables, between the dependent and independent variables and the one deflator (number of shares) that is not one of the variables produced automatically by the simulated data) might affect the conclusions drawn. Barth and Kallapur (1996) report that the degree of correlation between various deflators can be significantly different on actual US data than in their simulated data, but Barth and Clinch (2009) do not explicitly consider this issue.

Hence, it is possible that, in the simulated data, Barth and Clinch (2009) might not actually be capturing some potentially important features of the actual US data. These features include the increasing presence of loss firms in the actual data, firms with potentially different relationships between market value and accounting fundamentals. They also include the correlation structure between variables in their regression model and deflators. This would not be entirely surprising, given the complexities of their simulations and the comprehensive range of different issues addressed. Nonetheless,
the failure to capture these features might cause questioning of the generality of the conclusions reached as to the desirability of particular estimation practices for regressions of market value on book value and earnings.

2.3.4.3 Out-of-sample percentage valuation errors as an alternative metrics to investigate scale effect

Alternative metrics have been used to investigate scale-related effect in prior studies. Easton and Sommers (2003) and Akbar and Stark (2003b) investigate the properties of regression models in terms of (absolute) studentized residuals. The large studentized residuals for groups of larger firms are interpreted as demonstrating scale effects whereby large firms dominate the estimated coefficients. This problem is similar to the general problem of scale-related coefficients studied by Barth and Clinch (2009). The behaviour of the studentized residuals across size groups is then used to compare the effectiveness of a particular deflator in mitigating this scale effect. Easton and Sommers (2003) consider this issue using the same basic model discussed as above and apply it to US data. Akbar and Stark (2003b) study the basic benchmark model, and an expanded one, on UK data. Easton and Sommers (2003) conclude that, on US data, the use of closing market value as a deflator is the best approach in mitigating the scale effect studied. Akbar and Stark (2003b) find that this conclusion does not hold on UK data and, further, find that the influence of large firms is somewhat reduced by using

Arguing that using closing market value as a deflator can induce correlation between the error term and the independent variables in the regression, Lara, Grambovas and Walker (2007) suggest using the fitted contemporary market capitalization as a deflator.
additional value-relevant variables in an expanded model. In this case, conclusions reached on US data are not transferable to UK data.

Prior research papers investigating the properties of (regression) models found in market-based accounting research use actual data and, as a consequence, have to rely on indirect criteria to evaluate the properties of regressions, as the ‘true’ coefficients are unknown under this situation. Such indirect criteria include exploring the (absolute) studentized residuals by size grouping (Easton and Sommers, 2003), or out-of-sample proportional valuation errors, defined as the difference between the estimated market value from some estimated model and actual firm value divided by the actual firm value (Choi, O’Hanlon and Pope, 2006).

The underlying research approaches of both papers have similarities. Specifically, they propose a particular system of linear information dynamics. Both papers use accounting data to estimate the parameters of particular systems of linear information dynamics and convert the estimated parameters into multipliers of various accounting and other variables to produce predictions of firm value. The predictions of firm value are then compared with actual values, and the bias and accuracy of the predictions are evaluated. Implicit in this approach is the assumption that the parameters of the systems of linear information dynamics are stable over time, as is the underlying valuation model.

We follow the approach of Choi, O’Hanlon and Pope (2006) in examining proportional valuation errors between value estimates and actual market value in evaluating the
effectiveness of different estimation specifications. The difference between our study and that of Choi, O’Hanlon and Pope (2006) is, however, that, whereas they compare value estimates produced by two competing systems of linear information dynamics (and, hence, two competing valuation models), we primarily compare estimates of the same valuation model produced using various different model specifications and deflators.

We compare the effects of various estimation specifications using out-of-sample valuation errors, as discussed previously, benchmark valuation model against extended model; valuation model with and without ‘other information’; deflated models estimated with and without constant term, and the choice of different deflators. Further, following Choi, O’Hanlon and Pope (2006), we compare the valuation errors between estimating with full sample and those separating high- and low intangible asset firms. Take the choice of deflator as an example to explain how the approach works. Ceteris paribus, one deflator is superior to others if it produces a valuation model that is less biased and more accurate and, hence, the corresponding deflated model is arguably better specified and more reliable as a base model for the making of inferences about the additional accounting amounts that could be added to it in value relevance tests. For each deflator, we calculate proportional valuation errors equal to the intrinsic value estimates less the stock price six months after the corresponding balance sheet date, divided by the stock price. Valuation bias is measured as the mean (median) signed proportional valuation error, and valuation inaccuracy is measured as the mean (median) absolute, or mean square, proportional valuation error.
To summarize, our research evaluates different approaches to estimating various valuation models – the basic benchmark model with only earnings and book value as independent variables, and an extended model with additional variables – including the performance of cross-sectional valuation models with and without the incorporation of ‘other information’, the effectiveness of estimating the deflated model with and without a constant term, and the influence of estimating models on high- and low-intangible firms separately, in addition to exploring the effectiveness of different scale proxies.

2.4 Evaluation of valuation models using fundamental analysis approach

Fundamental analysis entails the use of information in the products of accounting practice, current and past financial statements, to indicate the underlying/intrinsic value of a firm. In discussing the major principle of fundamental analysis, Kothari (2001) suggests that “Cross-sectional tests of return predictability, or anomalies literature, examine whether the cross section of returns on portfolios formed periodically using specific trading rules is consistent with a model of expected returns like the CAPM.” (Kothari 2001, p110) The trading rules used in the prior research have been either univariate indicators like accounting accruals (Sloan, 1996), or multivariate indicators to earn long-horizon abnormal returns, examples of which include ratio-based fundamental analysis (eg., Ou and Penman, 1989a,b, Greig, 1992, Holthausen and Larcker, 1992, Stober, 1992, Setiono and Strong, 1998), and fundamental value strategies (e.g., Frankel and Lee, 1998, Dechow, Hutton and Sloan, 1999, Gregory, Saleh and Tucker, 2005). My proposed research falls into the second category using cross-sectional corporate valuation models as a tool for fundamental analysis.
2.4.1 Ratio-based fundamental analysis

Ou and Penman (1989a, b) resurrected interest in fundamental analysis by initiating rigorous academic research on earnings prediction based on a multivariate analysis of financial ratios (Kothari, 2001). Using the $Pr$ measure, the estimated probability of a positive earnings change, Ou and Penman (1989a, b) report positive abnormal returns to their $Pr$-measure-based fundamental strategy. Ou and Penman (1989a) conclude that the accounting system provides information that enhances valuation rather than garbling it. Ou and Penman (1989b) indicate that financial information predicts one-year ahead earnings and cash flow changes, and that future earnings and cash flows are not fully impounded in stock prices. They also indicate that an earnings-based trading strategy can earn higher excess returns than a cash flow-based trading strategy.

Greig (1992) examines the results of Ou and Penman (1989a, b) by controlling for cross-sectional differences in CAPM beta and firm size and reports that significant positive abnormal returns attributable to $Pr$ can be explained by the size effect. Stober (1992) suggests that the superior performance of the $Pr$ strategy continues for up to six years, and this persistence can be interpreted as compensation for risk in the US market. Ball (1992) restates this conclusion.

Holthausen and Larcker (1992) replicate the $Pr$ strategy in a period subsequent to that examined in Ou and Penman (1989a, b) and find that the $Pr$ effect does not sustain, as abnormal hedge returns are negative. They also adopt a more direct approach by predicting future stock returns instead of via earnings as in Ou and Penman (1989a, b). If the stock is predicted to have a positive abnormal return, they buy and hold for twelve
months, otherwise, sell short and hold. Their trading strategy documents positive market-adjusted returns.

In the UK, Setiono and Strong (1998) re-examine the value of fundamental analysis by adopting both the Ou and Penman (1989a, b) and the Holthausen and Larcker (1992) approaches to the prediction of UK stock prices. They also analyze the impact of financial distress and takeovers, which might provide alternative explanation for their results, in addition to controlling for potential sources of risks as in Greig (1992). Strikingly, Setiono and Strong (1998)’s mechanical implementation of the Pr strategy in the UK shows that an investor could use publicly available financial statement information to predict subsequent-year earnings changes and systematically earn abnormal investment returns. Contrastingly, such a strategy to predict one-year-ahead stock returns shows only weak and inconsistent evidence of abnormal returns (Setiono and Strong 1998, p632).

2.4.2 Fundamental value strategies

Extending multivariate fundamental analysis from ratio-based fundamental strategies, Frankel and Lee (1998), Dechow, Hutton and Sloan (1999) and Lee, Myers and Swaminathan (1999) in the US estimate the fundamental (intrinsic) value of equity stocks, and develop investment strategies on mispriced stocks as suggested by their fundamental values. One of the common features of this fundamental analysis research is that it estimates stocks’ fundamental value using Ohlson’s valuation approach (Ohlson 1995, and Feltham and Ohlson 1995).
Frankel and Lee (1998) estimate firms’ fundamental values using consensus analysts’ forecasts and a residual income model, and they find the value-to-contemporaneous stock price ratio \(V/P\) as a good predictor of cross-sectional returns, particularly over longer time horizons of over two or three year periods. Their results of the \(V/P\) effect sustains after controlling for market beta, the book-to-market ratio and firm size, which might have provided an explanation for the buy-and-hold abnormal returns.

Another empirical assessment of Ohlson’s residual income valuation model is Dechow, Hutton and Sloan (1999). Their analysis incorporates residual income information dynamics, and conducts tests that “entertain the possibility of temporary stock mispricing that can be systematically predicted by the particular valuation model” (Dechow, Hutton and Sloan, 1999, p27). Dechow, Hutton and Sloan (1999) use the ratio of the intrinsic model value to observed equity value as a predictor to form decile portfolios. Therefore, lower deciles consist of stocks that are overpriced relative to intrinsic value and are, therefore, expected to experience lower future stock returns. Higher deciles consist of stocks that are underpriced relative to intrinsic value, and are therefore expected to experience higher future stock returns. The hedge portfolio return is reported as positive, although with low statistical significance, which could indicate the superior predictive ability of the tested models with respect to future stock returns.

Dechow, Hutton and Sloan (1999) indicate that a simple valuation model that capitalizes analysts’ earning forecasts in perpetuity outperforms the other competing models at explaining contemporaneous stock prices. They also suggest a possible reason for the superior performance of the simple capitalization model is due to the fact that investors
overweight information in the analysts’ earnings forecasts and underweight information in current earnings and book value. (Dechow, Hutton and Sloan, 1999, p32)

Using Dechow, Hutton and Sloan’s (1999) fundamental value strategy, Gregory, Saleh and Tucker (2005) conduct a UK test of a modified version of an Ohlson model (Ohlson, 1995) with inflation adjustments, and they replicate the Dechow, Hutton and Sloan (1999) approach of portfolio testing. Consistent with the predictions of Ohlson model, they find that the modified abnormal earnings appear to mean revert, and the inflation-adjusted abnormal earnings model outperforms the standard version of Ohlson model in predicting one year ahead earnings in the UK. Gregory, Saleh and Tucker (2005) document that the standard model undervalues equities relative to the UK stock market, which is generally consistent with the empirical results in the US of Dechow, Hutton and Sloan (1999). Nonetheless, they find the undervaluation problem is replaced with an overvaluation problem with their inflation-adjusted valuation model, and their results persist after controlling for an industry effect.

To summarize, prior fundamental analysis and valuation research shows the possibility of using either ratio or valuation models for superior intrinsic value estimation or fundamental value analysis to identify mispriced securities and generate abnormal stock returns from investment strategy. Prior research also indicates that US empirical results do not automatically carry over to the UK stock market, and fundamental analysis based on corporate valuation models in the UK is limited.
A set of fundamental analysis papers attribute the profitability of strategies based on accounting data to the misspecification of the abnormal returns model itself, from which they believe that certain risk factors have been omitted (Greig, 1992, Holthausen and Larcker, 1992 and Stober, 1992). Therefore, it is crucial to use appropriate risk-adjustments in measuring unexpected returns, i.e. to evaluate portfolio performance controlling for risk measures.

The first study investigating the relationship between firm size and average stock returns in the UK is Levis (1985), who finds the smallest size decile of firms outperforms the largest size decile by a significant 6.5% per year, although unstably over the period for 1958 – 1982. Strong and Xu (1997) re-examine the cross-section of expected returns for UK stock market over the period of 1973 to 1992, and conclude that firm size is strongly associated with cross-sectional variation in returns – small capitalization stocks have higher average returns than big firms – consistent with the “small-firm effect” observed in the US (Banz, 1981, and Fama and French, 1992). Strong and Xu (1997) also find a value premium by using the book-to-market ratio and earnings-to-price ratios as measures of value. Gregory, Harris and Michou (2001) document similar empirical evidence using a value strategy in the UK over the period 1975-1998. Dimson, Nagel and Quigley (2003) restate prior results by documenting similar return premiums for value stocks in the UK. Further, Al-Horani, Pope and Stark (2003) suggest that RD dominates book-to-market as an explanatory factor for returns in the UK by providing a cross-sectional analysis over the period 1990-1999, a result also found in Dedman, Mouselli, Shen and Stark (2009) over a longer period of time.
In the US, empirical evidence has shown that RD is associated positively with the cross-section of stock returns. (Lev and Sougianis, 1996, 1999; and Chan, Lakonishok and Sougianis, 2001) Al-Horani, Pope and Stark (2003) present evidence that the cross-section of UK expected stock return is positively related to RD activity, the association persist even after controlling for book-to-market and size effect. They also extend the three-factor Fama and French model to incorporate RD as an additional factor measured by the difference between the returns of a portfolio containing firms with RD expenditures and that reporting zero RD expenditures, and find that factor useful.

2.4.3 Abnormal returns tests

In order to evaluate the performance of investment strategies, it is essential to estimate risk-adjusted abnormal returns. There are several possibilities to establish benchmarks for estimation of expected returns. One approach to estimate risk-adjusted abnormal returns is to use an asset pricing model (e.g., CAPM or Fama and French (1993) three factor model), where a time series of actual decile portfolio returns are regressed on one or more risk factors. The estimated constant term in the time series regression of portfolio returns is an estimate of the risk-adjusted abnormal return of the portfolio strategy. As a consequence, the constant term generated is usually tested against the null hypothesis that it is equal to zero. This method of estimating abnormal returns has been used by prior UK studies (e.g., Liu, Strong and Xu, 1999, 2003, and Gregory, Harris and Michou, 2001, 2003). However, recent evidence by Michou, Mouselli and Stark (2008) suggests that the three factor model provide an inadequate control for risk irrespective of the different ways in which the factors have been constructed by various
prior studies in the UK. Therefore, this study does not employ risk factor models to estimate risk-adjusted abnormal returns.

Another approach is to match each share with a benchmark portfolio for a given period of time and the abnormal return for the share for the given period is the actual return for the share less the matched portfolio return. The portfolio abnormal return for any given period is then a weighted average of the individual share abnormal returns. In this study, benchmark returns are the return on portfolios of firms of similar size (size-matched returns), the return on portfolio of firms with similar book-to-market ratios (book-to-market adjusted returns), or the returns on firms with similar combination of size and book-to-market ratio (size and book-to-market adjusted returns). This can be justified by prior studies that suggest the presence of size and book-to-market effects in the UK (e.g., Michou, Mouselli and Stark, 2008, Strong and Xu, 1997).

2.5 Summary

This chapter provides a summary of several streams of literature relevant to the two strands of empirical research proposed for this study. The review of studies on scale and scale effect in both the US and UK shows that a gap exists with respect to using an alternative metric of out-of-sample valuation errors to evaluate various estimation specifications. We follow the approach of Choi, O’Hanlon and Pope (2006) in examining out-of-sample proportional valuation errors between value estimates and actual market value in evaluating the effectiveness of different estimation specifications.
The difference between our study and that of Choi, O’Hanlon and Pope (2006) is, however, that, whereas they compare value estimates produced by two competing systems of linear information dynamics (and, hence, two competing valuation models), we primarily compare estimates of the same valuation model produced using various different model specifications, benchmark valuation model against extended model; valuation model with and without ‘other information’; deflated models estimated with and without constant term, and the choice of different deflators. Further, following Choi, O’Hanlon and Pope (2006), we compare the valuation errors between estimating with full sample and those separating high- and low intangible asset firms.

Reviewing previous studies on Ohlson valuation modelling framework and value relevance studies conducted using Ohlson model suggests that the residual income valuation model is found to be associated with “mispricing” effect in the US and UK, so it would be interesting to conduct fundamental analysis to find out the profitability of investment strategies generated using firm valuation models that are developed within the UK context (i.e., to use the in-sample valuation errors generated from the firm valuation models to form decile portfolios so as to evaluate the performance of these models). The next chapter describes the research methodology adopted in the two empirical studies in this research.
CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

The research background and relevant literature of this dissertation are discussed in chapter 2. In this chapter, we discuss the research methods used to evaluate firm valuation models in the following two empirical chapters. This thesis consists of two empirical studies. The first concerns the efficiency of various model estimation specifications using out-of-sample valuation errors as the criterion for evaluation (Chapter 5). The second concerns the performance of firm valuation models using portfolio analysis as the criterion for evaluation (Chapter 6).

Section 3.2 explains the process of model development. Section 3.3 illustrates the process of deriving the firm valuation models that will be evaluated in the empirical chapters, various specification issues associated with the empirical estimation of firm valuation models, and a discussion of calculating and analyzing out-of-sample valuation errors to evaluate different model estimation specifications. Section 3.4 discusses how decile portfolios are formed using in-sample valuation errors generated from firm valuation models, and how to measure portfolio performance based upon appropriate risk control methods. The chapter ends with a brief summary in section 3.5.
3.2 Model development

A frequently employed benchmark model in value relevance studies is that the market value of equity can be represented as a linear function of book value of equity and earnings, together with a constant term to capture the effects of omitted variables. This leads to the first empirical specification in equation (3.1) below:

\[ MV = \alpha_0 + \alpha_1 BV + \alpha_2 E + \varepsilon \]  

(3.1)

where \( MV \), \( BV \) and \( E \) are market value of equity, book value of equity and earnings, respectively, and \( \varepsilon \) is the regression error term.

In addition to examining the properties of the model in equation (3.1), we then employ an extended model, which combines variables found significant in Rees (1997) and Akbar and Stark (2003a):

\[ MV = \alpha_0 + \alpha_1 BV + \alpha_2 E + \alpha_3 RD + \alpha_4 D + \alpha_5 CC + \alpha_6 CE + \varepsilon \]  

(3.2)

where, in addition to the definitions above, \( RD \), \( D \), \( CC \) and \( CE \) are research and development expenses, dividends, capital contributions and capital expenditures, respectively.13

As in Akbar and Stark (2003a), one way of justifying the model in equation (3.2) is that market value can be represented as the present value of future expected net shareholder cash flows, and the variables follow on LID process. The basis of the model development process is $z_t$, a vector of variables:

$$z_t = \begin{bmatrix} BV_t \\ E_t \\ RD_t \\ D_t \\ CC_t \\ CE_t \end{bmatrix}$$

(3.3)

where $BV_t$ represents book value at time $t$, $E_t$ represents earnings plus research and development expenditures at time $t$, $RD_t$ represents research and development expenditures at time $t$, $D_t$ represents dividends at time $t$, and $CC_t$ represents capital contributions at time $t$, and $CE_t$ represents capital expenditures at time $t$.

Then, it is assumed that the stochastic evolution through time of $z_t$, can be modelled in the following way:

$$z_t = \Omega z_{t-1} + \epsilon_t$$

(3.4)

where $\Omega$ is a (6 by 6) matrix of time-invariant parameters and $\epsilon$ is an (6 by 1) vector of mean zero random variables. If market value can be represented as the present value of future expected net shareholder cash flows, Ohlson (1989) then suggests that corporate
value can then be modelled as a linear function of the variables in $z_t$. Thus, market value, $MV$, can be expressed as the extended model in equation (3.2).\(^{14}\)

We also include a variable capturing ‘other information’ using the approach of Akbar and Stark (2003a) which minimises data loss in the estimation of this variable, to investigate the impact of “other information” in firm valuation models.\(^{15}\) We might expect ‘other information’ ($OI$) to increase the completeness and reliability of valuation models. As a consequence, we estimate model (3.1) and (3.2) with and without ‘other information’ respectively:

\[
MV = \alpha_0 + \alpha_1BV + \alpha_2E + \beta_1OI + \varepsilon \]  \hspace{1cm} (3.5)

\[
MV = \alpha_0 + \alpha_1BV + \alpha_2E + \alpha_3RD + \alpha_4D + \alpha_5CC + \alpha_6CE + \beta_2OI + \varepsilon \]  \hspace{1cm} (3.6)

In some US studies (Dechow, Hutton and Sloan, 1999, Ohlson 2001, Hand and Landsman 2005, Choi, O’Hanlon and Pope, 2006, etc.), the empirical implementation of $OI$ involves using consensus earnings forecasts in the valuation model as a proxy, which

\(^{14}\) We also try adding one variable at a time to build up to the extended model from the benchmark model. That is, we also examined the models as below:

\[
MV = \alpha_0 + \alpha_1BV + \alpha_2E + \alpha_3RD + \varepsilon \\
MV = \alpha_0 + \alpha_1BV + \alpha_2E + \alpha_3RD + \alpha_4D + \varepsilon \\
MV = \alpha_0 + \alpha_1BV + \alpha_2E + \alpha_3RD + \alpha_4D + \alpha_5CC + \varepsilon \\
MV = \alpha_0 + \alpha_1BV + \alpha_2E + \alpha_3RD + \alpha_4D + \alpha_5CC + \alpha_6CE + \varepsilon
\]

Analysing these models do not provide results significant different enough from the benchmark and the extended model to be presented.

\(^{15}\) Data coverage in IBES is about 500 firms out of over 1000 on average across the years of observation. FactSet (previously JCF) provides a slightly better coverage of UK companies, but FactSet estimation data only goes back to 1996, while the coverage we require is from 1990 to 2006.
can cause a large shrinkage in sample size in the UK context.\textsuperscript{16} Akbar and Stark (2003a), hence, develop an alternative proxy for ‘other information. Consistent with Ohlson (2001), their proxy is built on the assumption that ‘other information’ is single-dimensional and, although $OI_t$ is not directly observable, we can use previous period’s ‘other information’, $OI_{t-1}$, as a proxy for $OI_t$.

To estimate $OI_{t-1}$, we start with the generalized version of models (3.5) and (3.6) as below in equation (3.7):

$$MV_{t-1} = \alpha_0 + \sum \alpha_i AV_{it-1} + \beta OI_{t-1}$$ \hspace{1cm} (3.7)

where $\sum \alpha_i AV_{it-1}$ represents the linear combination of the accounting variables in equations (3.5) and (3.6), and $OI_{t-1}$ is ‘other information’ for period $t-1$. Equation (3.7) can be restated as:

$$\beta OI_{t-1} = MV_{t-1} - \alpha_0 - \sum \alpha_i AV_{it-1}$$ \hspace{1cm} (3.8)

which indicates that we can obtain $\beta OI_{t-1}$, a multiple of $OI_{t-1}$, if we can estimate $\alpha_0$ and the $\alpha_i$. We can approximate these coefficients by estimating the following cross-sectional regression:

$$MV_{t-1} = \alpha_0 + \sum \alpha_i AV_{it-1} + \epsilon_{t-1}$$ \hspace{1cm} (3.9)

\textsuperscript{16} Linear information dynamics (Ohlson 1995) suggests $E(R_{I_{t+1}}) = \omega R_{I_t} + \gamma OI_t$. Hence, to estimate ‘other information’, we need to estimate next period’s expected residual income $E(R_{I_{t+1}})$. Ohlson (2001) assumes that $E(R_{I_{t+1}})$ can be treated as observable: $E(R_{I_{t+1}}) = E(E_{t+1}) - kBV_t$, where $E(E_{t+1})$ is the consensus earnings forecast.
and, for each firm, we can proxy $\beta OI_{t-1}$ by $\epsilon_{t-1}$.

As a consequence, for year $t$, $\beta OI_{t-1}$ is then included in the cross-sectional regression as a proxy for $OI_t$, as shown below:

$$MV_t = \alpha_0 + \sum \alpha_i AV_i + \beta_i (\beta OI_{t-1}) + \epsilon_t$$  \hspace{1cm} (3.10)

### 3.3 Evaluating firm valuation models using out-of-sample valuation errors

As discussed in the previous chapter of literature review, we intend to compare the effects of various estimation specifications using out-of-sample valuation errors, these specifications include: (i) the benchmark valuation model against the extended model; (ii) valuation models with and without ‘other information’; (iii) deflated models estimated with and without a constant term; and (iv) the choice of different deflators. Further, following Choi, O’Hanlon and Pope (2006), we compare the valuation errors from estimating the various models on the full sample with those resulting from separate estimation on high- and low intangible asset firms.

Take the choice of deflator as an example to explain how the metric works. *Ceteris paribus*, one deflator is superior to others if it produces a valuation model that is less biased and more accurate and, hence, the corresponding deflated model is arguably better specified and more reliable. Valuation bias is measured as the mean (median) signed proportional valuation error, and valuation inaccuracy is measured as the mean (median) absolute, or mean square, proportional valuation error. For each deflator, we calculate
proportional valuation errors equal to the intrinsic value estimates less the stock price six months after the corresponding balance sheet date, divided by the stock price.

3.3.4 Model estimation specifications

3.3.4.1 Benchmark versus extended model

The first research questions raised in our empirical study using out-of-sample valuation errors is to investigate if the accounting variables found to be empirically associated with market value could be included in the base model to form a better specified benchmark model for value relevance studies. In particular, building on Rees (1997) and Akbar and Stark (2003a), we use an extended firm valuation model, as discussed in Section 3.2 of model development, Model (3.1), where corporate value is modelled as a linear function of book value, earnings, research and development expenditures, dividends, capital contributions and capital expenditures. We compare this extended model to the benchmark model often used in value relevance studies mentioned in section 3.2. We expect the model in equation (3.2) to be better specified than model (3.1) in terms of producing less biased and more accurate value estimates.

We also include a variable to capture ‘other information’, using the approach of Akbar and Stark (2003a) which minimises data loss in the estimation of this variable, to investigate the impact of “other information” in model specifications. The estimation method of “other information” is discussed in section 2.2.3.8 above.
3.3.4.2 Choice of deflator – proxy of scale

To avoid inappropriate inferences drawn from the estimation results, most value relevance research employs well-established techniques to mitigate the effects of various econometric issues that arise in the studies. Econometric problems include coefficient bias induced by correlated omitted variables, errors-in-variables, cross-sectional differences in valuation parameters, and inefficient coefficient standard errors induced by heteroscedasticity. Most accounting research deflates the valuation model by some measure of “size”, or uses White (1980) consistent standard error and covariance estimates when obtaining t-statistics, or both, to reduce the effects caused by these econometric problems, without going into much detail about the essence of these issues and the effects of the measures adopted.

Further, a group of recent studies, as discussed in the literature review, identify and analyse econometric problems that can arise in the context of value relevance studies.¹⁷ This problem is that inappropriate inferences can be drawn from samples of firms exhibiting substantial size-related variation. This problem is sometimes referred to in these studies as the ‘scale effect’. These studies offer conflicting recommendations for mitigating scale effects, and the differing treatments of scale problems reflect the fact that there is not a single well-defined concept, or problem, of scale in accounting research. Nonetheless, concerns with ‘scale effects’ represent a broad distrust that reflects a variety of potential econometric effects mentioned in the previous paragraph, and deflation is still regarded as one of the effective measures to mitigate general

econometric problems associated with “scale”. The discussion of the most effective
deflator, however, remains unresolved.

Using out-of-sample valuation errors, we compare the performance of various different
deflators, all of which been viewed as proxies for scale and have been used in prior value
relevance studies when estimating firm valuation models. We attempt to identify which
deflator produces the best specified valuation models.

3.3.4.3 Alternative remedies for econometric problems

Once a suitable deflator has been chosen, a further estimation issue arises in value
relevance studies based upon firm (undeflated) valuation model equations. One line of
logic (mainly based upon the idea that the ‘scale effect’ is heteroscedasticity) is that the
equation should be divided through by the deflator. As a consequence, the deflated
valuation model only contains a constant term if the deflator is a variable in the
undeflated equation. Furthermore, the inverse of the deflator is also a variable in the
estimated equation. Many studies in the valuation relevance literature, however, do not
adopt this approach. Instead, they deflate the dependent and independent variables by a
chosen deflator and substitute the deflated variables for the undeflated variables in the
valuation model and proceed as if this approach is equivalent to estimating the undeflated
model. In effect, however, this procedure is equivalent to including the deflator as a
variable in the undeflated valuation equation. As Akbar and Stark (2003b) point out,
comparing deflators under this approach cannot be separated from comparing competing

18 We include a constant term in the valuation model equations to capture the mean effect of omitted
variables.
valuation models. As a consequence of the above, we also compare the performance of deflated models which include constant terms with the performance of those that do not.

### 3.3.4.3.1 Heteroscedasticity

With cross-sectional data we often expect heteroscedasticity, and this can result in an underestimation of the coefficient standard errors (and, thus, an overestimation of the $t$-statistics) when conventional ordinary least squares (OLS) estimation approaches are employed. There are usually two remedies suggested and used for solving the heteroskedasticity problem. The first involves transforming the data to logs, and the second involves deflating the variables by some measure thought to be the source of the heteroscedasticity. Such measures are typically ones that capture the ‘size’, or ‘scale’ of the observation. We focus on the second type of solution in this study.

Again we start with the generalized version of models (3.1) and (3.2) as below in equation (3.11):

$$ MV = \alpha_0 + \sum \alpha_i AV_i + \varepsilon $$

(3.11)

Assume equation (3.11) suffers from heteroscedasticity, which might result from size differences across firms. That is:

$$ MV = \alpha_0 + \sum \alpha_i AV_i + S\varepsilon $$

(3.12)

where $S$ represents the source of heteroscedasticity. Generally, $S$ is likely to be a measure of the ‘size’ or the ‘scale’ of the observation. Although heteroscedasticity does
not lead to bias in the estimated coefficients, $\alpha_0$ and the $\alpha_i$, it biases the standard errors of the coefficients, resulting in potentially incorrect inferences because the standard OLS method for calculating coefficient estimate standard errors and, thus, t-statistics, assumes homoscedasticity.

One common solution to such econometric problem in value relevance studies is to deflate both sides of the equation (3.12) by $S$ and estimate:

\[
\frac{MV}{S} = \hat{\alpha}_0 \frac{1}{S} + \sum \hat{\alpha}_i \frac{AV_i}{S} + \epsilon
\]  

(3.13)

An implication of so doing is that, empirically, the above regression is estimated without a constant term. Instead, the coefficient of the new independent variable, $\frac{1}{S}$, provides an estimate of the constant term $\alpha_0$ of model (3.12). If the source of heteroscedasticity has been correctly identified, the error term of model (3.13) is now homoscedastic.

\subsection{3.3.4.3.2 A correlated omitted variable and heteroscedasticity}

Now assume the generalized model (3.11) suffers from both the absence of a correlated omitted variable, related to size, and size-induced heteroscedasticity. Thus, the ‘true’ model is:

\[
MV = \alpha_0 + \sum \alpha_i AV_i + \gamma S + S\epsilon
\]  

(3.14)
$S$ is presumed correlated with the included independent variables $AV_i$. In this context, as long as the omitted variables in a regression equation are uncorrelated with the included independent variables, OLS regression will produce unbiased estimates, although t-tests on the coefficients of the included independent variables will be less likely to reject the null hypothesis. When the omitted variables, however, are in fact correlated with the included independent variables, OLS regression will produce biased and inconsistent estimates.

The remedy is again to deflate both sides of the equation (3.14) by $S$, producing equation (3.15):

$$\frac{MV}{S} = \gamma + \hat{\alpha}_0 \frac{1}{S} + \sum \hat{\alpha}_i \frac{AV_i}{S} + \varepsilon$$

which, from an empirical point of view, suggests running regression (3.13) with a constant term. Equation (3.15) provides a specification mitigating the problems of both omitted correlated variables and heteroscedasticity, on the assumption that $S$ adequately captures both the effects of correlated omitted variables and the source of heteroscedasticity.

### 3.3.4.3.3 Model equations estimated

Given the above discussion, we investigate the effects of using different estimation equations corresponding to general equations (3.13) and (3.15). The equations we estimate are:
Equations (3.16) to (3.19) allow us to make a number of comparisons. We can compare regressing without and with constant term \( \gamma \) by comparing the results for equations (3.16) and (3.18), or (3.17) and (3.19). We can compare the results with and without ‘other information’, using equations (3.16) and (3.17), or (3.18) or (3.19). We can also compare the results between using a simple valuation model, when \( i = 1, 2 \) and the model is specified as including \( BV \) and \( E \) alone as the accounting variables, with the case when \( i = 1, \ldots, 6 \) and we include \( BV, E, RD, D, CC, CE \) as the accounting variables. Finally, to compare the effect of different ‘scale’ proxies, \( S \), we use five different deflators, as discussed in the previous chapter of literature review - closing book value (\( BV \)), sales (\( SALES \)), number of shares (\( NoSHARES \)), opening market value (\( OMV \)) and closing market value (\( MV \)).

As discussed in section 3.2, with deflated models, we proxy \( \beta_{OI_{t-1}} \) by \( S_{t-1} \epsilon_{t-1} \). Hence, for year \( t \), we use \( S_t \epsilon_{t-1} \) as a proxy of \( OI_{t-1} \) and \( \epsilon_{t-1} \) can be obtained by running the appropriate deflated regression with all available data up to year \( t-1 \), with \( \epsilon_{t-1} \) the firm-specific error term.
3.3.4.4 Separating the full sample into high and low-intangible asset firms for estimation

Following Choi, O’Hanlon and Pope (2006), who suggest that the impact of accounting conservatism is likely to differ between high-intangible and low-intangible sectors, we estimate each specific model specification both on the full estimation sample and after separating the full estimation sample into high-intangible firms and low intangible firms. Choi, O’Hanlon and Pope (2006) follow prior US studies (Francis and Schipper, 1999, Amir, Lev and Sougiannis 1999) in splitting the sample into high- and low-intangible firms, using industrial classifications. In particular, they identify certain industries as “high-technology”, such as drugs, publishing, research and development services etc. We find, however, that similar industrial classification data available for UK firms are not as detailed as that of US. Hence, we believe that the market-to-book ratio can be used to fulfil the same purpose of splitting the full sample into high- and low-intangible firms, and firms with higher (upper quartile) market-to-book ratios are assigned to the high-intangible group, and those with lower (lower three quartiles) ratios are assigned to the low-intangible group.\footnote{Market-to-book ratio is calculated using market value six months after the financial year end date, and book value reported in the annual report. Details of variable definitions will be presented in Chapter 4.}

3.3.5 Out-of-sample percentage valuation errors and measures of valuation bias and accuracy

It is well documented in the economics and econometrics literature that, in a forecasting (or the equivalent term “prediction”) environment, “because the data for the ex-post
forecast period have not been used to obtain the estimates of the parameters, ex-post forecasts provide a true test of the model’s forecasting ability” (Ramanathan, 1998, p564). Similarly, Pindyck and Rubinfeld (1998, p203) states that “in an ex post forecast, observations on both endogenous variables and the exogenous explanatory variables are already known with certainty during the forecast period. Thus, ex post forecasts can be checked against existing data and provide a means of evaluating a forecasting model.” Ex post forecasts result from estimating the parameters on historical data and using the estimated parameters to predict estimators one period forward. Therefore, ex post forecasting valuation errors are the equivalent of out-of-sample valuation errors referred to in this study. Overall, given that ex post forecasts errors are commonly employed for the evaluation of economic models (e.g., comparing macroeconomic models), there is precedent also from empirical research in other disciplines, and not just accounting, for the use out-of-sample valuation errors to assess various valuation model specifications in our context.

Our procedure for estimating out-of-sample valuation errors follows closely that used by Choi, O’Hanlon and Pope (2006). Implicit in the approach of Choi, O’Hanlon and Pope (2006) is that the coefficients of the linear information dynamics system they estimate are stable over time. As a consequence, and given a particular start date for the data, it makes sense to progressively pool more and more years’ of data to estimate coefficients. We adopt a similar underlying assumption – that the accounting-based valuation model is stable over time - and, hence, follow a similar approach of progressively pooling more and more years’ of data to estimate the coefficients of the model.
For each year $t$, we use UK accounting and market data, available up to year $t$, to run the regressions using the deflated models in equations (3.16) through (3.19) above, to obtain the relevant estimated coefficients for year $t$.

These coefficients are then applied to the accounting and market data of year $t+1$ for each firm $j$ to calculate the estimated market value. To illustrate for equation (3.17)

$$MV_{j,t+1}^{Est} = S_{j,t+1} \cdot \frac{MV_{j,t+1}}{S_{j,t+1}} = S_{j,t+1} \left( \alpha_0 \frac{1}{S_{j,t+1}} + \sum \alpha_i \frac{AV_{j,t+1}}{S_{j,t+1}} + \beta \frac{OI_{j,t+1}}{S_{j,t+1}} \right)$$

(3.20)

where $MV_{j,t+1}^{Est}$ represents the estimated market value for firm $j$ at year $t+1$.

$MV_{j,t+1}^{Est}$ is then compared with the actual market value for year $t+1$, $MV_{j,t+1}^{Act}$. The proportional valuation error for each firm for year $t+1$ is calculated as:

$$\omega_{j,t+1} = \frac{MV_{j,t+1}^{Est} - MV_{j,t+1}^{Act}}{MV_{j,t+1}^{Act}}$$

(3.21)

and $\omega_{j,t+1}$ is defined as the proportional valuation error ratio for firm $j$ at year $t+1$. Valuation bias is measured by the mean valuation error and valuation accuracy is measured by the mean absolute proportional valuation error and the mean squared proportional valuation error.

For each of the metrics of mean valuation errors, we test the null hypothesis that the mean of that metric is zero, using a $t$-test. For both measures of valuation accuracy, the
lowest value is the most accurate. The best estimation specification is expected to provide the least valuation bias and most accurate value estimates.

When estimating the models on high- and low-intangible assets firms separately, the procedure is slightly different. Taking year 1996 estimation (splitting high- and low-intangible firms) as an example, we split the sample for each year first, then pool the data from 1990 to 1996, run valuation model regressions and the coefficients generated are then applied to year 1997. These steps so far are done with high- and low-intangible assets firms separated. Finally the valuation errors calculated for the sub-samples are combined for year 1997.

### 3.4 Evaluating firm valuation models using portfolio analysis

Further to the discussion of Dechow, Hutton and Sloan (1999) in the chapter of literature review who provide an empirical assessment of the residual income valuation model proposed by Ohlson (1995), we find it particularly interesting that they consider in their study whether the values implied by the competing valuation models are able to predict future stock returns by developing portfolio investment strategies, the traditional concern of fundamental analysis. We intend to find out if we can use portfolio analysis approach to evaluate the effectiveness of firm valuation models, the extended model (3.2), with “other information”, in particular. Instead of the out-of-sample valuation errors, we follow Dechow, Hutton and Sloan (1999) and use the in-sample proportional valuation error ratio to rank sample firms, form decile portfolios based on this ratio, and analyze the abnormal returns of the decile portfolios and the difference in monthly abnormal returns between the two extreme deciles.
3.4.1 Creating rankings and forming decile portfolios

Our procedure for estimating the in-sample proportional valuation errors for ranking follows closely that used by Dechow, Hutton and Sloan (1999). For each year \( t \), we use UK accounting and market data available for year \( t \) only, to run the regressions using the deflated models in equations (3.16) through (3.19) above, to obtain the relevant estimated coefficients for year \( t \).\(^{20}\)

These coefficients are then applied to the accounting and market data of year \( t \) for each firm \( j \) to calculate the estimated market value implied by the firm valuation model examined. To illustrate for equation (3.17)

\[
MV_{j,t}^{\text{Est}} = S_{j,t} \cdot \frac{MV_{j,t}}{S_{j,t}} = S_{j,t} \cdot (\alpha_0 \cdot \frac{1}{S_{j,t}} + \sum \alpha_i \frac{AV_{j,t,i}}{S_{j,t}} + \beta \frac{OI_{j,t}}{S_{j,t}})
\]

(3.22)

where \( MV_{j,t}^{\text{Est}} \) represents the market value implied by the firm valuation model for firm \( j \) at year \( t \).

\( MV_{j,t}^{\text{Est}} \) is then compared with the actual market value for year \( t \), \( MV_{j,t}^{\text{Act}} \). The proportional valuation error for each firm for year \( t \) is calculated using equation (3.21), restated as below:

\(^{20}\) Different from the way out-of-sample valuation errors are generated, we only use one year’s data for estimation, instead of stacking all data past years’ data.

\(^{21}\) Taking year 1996 estimation (splitting high- and low-intangible firms) as an example, we split the sample for year 1996, run cross-sectional regression and the coefficients generated are then applied to year 1996 sample. These steps so far are done with high- and low-intangible firms separated. Finally, combine the valuation errors for year 1996 for the rankings.
where $\omega_{jt}$ is defined as the proportional valuation error ratio for firm $j$ at year $t$, which is calculated annually to determine the firm rankings.

Then, firms are ranked by their error ratios, with the lowest error ratio at the top, and the highest error ratio at the bottom. If the model provides a superior estimate of intrinsic value relative to market value, we would expect the market to correct its error in the future and revert towards the predicted value.\(^{22}\)

For firms with a positive error ratio, i.e. $\omega_{jt} > 0$, and, hence, $MV_{jt}^{Ext} > MV_{jt}^{Act}$, this indicates that these firms are undervalued / underpriced by the market according to the underlying/intrinsic value estimated by the valuation model and, therefore, these firms are predicted to have positive abnormal stock returns, since we expect the future market price to rise to revert to the model estimation. In contrast, for the firms with a negative error ratio, $\omega_{jt} < 0$ and, $MV_{jt}^{Ext} < MV_{jt}^{Act}$, implying that the current market value is higher than the estimated intrinsic value of the firm, accordingly, we expect these firms to have negative abnormal stock returns.

The logic is straightforward here. If the firm valuation model is correctly specified and captures intrinsic firm values better than market value, pricing errors predicted using the

\[^{22}\text{If the market is efficient, we would expect the errors generated from the models are random.}\]
valuation model can be used to form decile portfolios with the properties that firms with lower/higher pricing errors are expected to have lower/higher future returns, and, hence, we expect to observe the difference between the abnormal return of two extreme portfolios is significantly different from zero.

3.4.2 Buy-and-hold strategies

Take year 1996 as an example to explain how the portfolio investment strategy is carried out. For all the firms with accounting variables available for the regression estimation and generating the error ratio $\omega_{jt}$ in 1996, we rank the firms with their error ratio. We assume that the decile portfolios are formed on July 1st, 1997. Each decile portfolio is held for a year. Further, we examine another strategy whereby the bottom decile with high $\omega_{jt}$, which contains firms predicted to have higher abnormal returns, is bought and held for twelve months and the top decile, with firms expected to have low abnormal returns, is sold short and held until June 30th, 1998. We repeat the same investment strategies every year during the sampling period.

3.4.3 Portfolio performance assessment

3.4.3.1 Monthly portfolio raw returns

To assess the profitability of the investment strategy above, we need to decompose and observe the monthly buy-and-hold portfolio returns. This section describes the method of

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23 Because market value data required for estimation process is defined as the market value six months after the financial year end date. Variable definitions will be discussed in details in the next chapter.
calculating monthly returns over the twelve-month holding period, based on the decomposed buy-and-hold method proposed by Liu and Strong (2009), who suggest that the individual monthly portfolio return over a multi-month holding period is a weighted average with the weight assigned to each stock in the portfolio depending upon the stock’s performance over previous months of the holding period.²⁴

Suppose an investor holds a portfolio of $N$ stocks for $m$ months, the monthly portfolio return $r_{pt}$ for portfolio $p$ in month $t$ of the holding period is:

$$r_{pt} = \sum_{i=1}^{N} w_{it} r_{it} \quad (3.24)$$

where $w_{it}$ is the weight of investment for each individual stock $i$ within the portfolio at the beginning of month $t$, with $\sum_{i=1}^{N} w_{i} = 1$, and the monthly return for an individual stock $i$ in month $t$, $r_{it}$ is given by:

$$r_{it} = \frac{P_{it} + D_{it} - P_{i,t-1}}{P_{i,t-1}} \quad (3.25)$$

where $P_{it}$ is stock $i$’s price per share at the end of month $t$, and $D_{it}$ is stock $i$’s dividend per share with the ex-dividend date falling in month $t$.

²⁴ Note that this is different from the traditional method of calculating either equally-weighted or value-weighted monthly portfolio return, where the weight of individual stock’s return is either $1/N$ ($N =$ number of constituent firms within the portfolio) or the stock’s market value relative to the total of the market value of all stocks within the portfolio at the beginning of that particular month of the holding period.
To calculate the monthly portfolio return $r_{pt}$, we then need to determine the weight $w_i$, based on the principle that these monthly returns $r_{pt}$ should be the return earned by an investor who holds the portfolio and reflect the investor wealth by the end of month $t$. Assume an investor’s investment in stock $i$ at the beginning of the holding period is $M_{i0}$, and the wealth will increase/decrease to $M_i$ by the end of the holding period. The wealth values are the bases for forming portfolio weights. Given the monthly return for each stock $r_i$, we use the formula below to calculate the wealth that the investor actually obtains by the end of each holding period month:

$$M_{it} = M_{i0} \prod_{j=1}^{j=t} (1 + r_{ij})$$

(3.26)

To illustrate how weights are calculated, assume the investor only holds two stocks, $a$ and $b$, for two months, $t = 2$, and the initial investment for each stock at $T_0$ is $M_{a0}$ and $M_{b0}$ in each stock. Table 3.1 below presents the change of wealth for the investor over two-month holding period, with an important condition that any dividends paid are reinvested in the same stock at the beginning of next holding period month:
The table above demonstrates that the weight of investment in stock \( i \) for month \( t \) is determined by the prior return history (i.e. its performance over the previous \( t - 1 \) months). For instance, the weight for stock \( a \) at the end of the investment period \( t = 2 \) is determined by the weight of investor’s return on stock \( a \) by the end of previous holding period month \( t = 1 \): 

\[
\frac{M_{a1}}{M_{a1} + M_{b1}},
\]

with the investor wealth \( M_{a1} \) and \( M_{b1} \) depending upon the stock’s performance over previous holding-period months. The process of identifying weights for each month can then be generalized as the formula below:

\[
\frac{R_t}{R_{t-1}} - 1 = \frac{M_{a1} + M_{b1}}{M_{a1} + M_{b1}} - 1 = \frac{M_{a0} + M_{b0}}{M_{a0} + M_{b0}} - 1 = \frac{M_{a0} + M_{b0} - r_{a1} + M_{b0} + M_{b0} - r_{b1}}{M_{a0} + M_{a0} + M_{a0} + M_{b0}} - 1 = \frac{M_{a0} + M_{b0} - r_{a1} + M_{b0} + M_{b0} - r_{b1}}{M_{a0} + M_{a0} + M_{a0} + M_{b0}} - 1
\]

\[
\frac{R_t}{R_{t-1}} - 1 = \frac{M_{a2} + M_{b2}}{M_{a1} + M_{b1}} - 1 = \frac{M_{a1} + M_{b1}}{M_{a1} + M_{b1}} - 1 = \frac{M_{a1} + M_{b1} - r_{a2} + M_{b1} + M_{b1} - r_{b2}}{M_{a1} + M_{a1} + M_{a1} + M_{b1}} - 1 = \frac{M_{a1} + M_{b1} - r_{a2} + M_{b1} + M_{b1} - r_{b2}}{M_{a1} + M_{a1} + M_{a1} + M_{b1}} - 1
\]
\[ w_{it} = \frac{M_{i0} \prod_{t=2}^{t-1} (1 + r_{it})}{\sum_{i=1}^{N} M_{i0} \prod_{t=2}^{t-1} (1 + r_{it})} \]  

(3.27)

Note that investor’s initial investment \( M_{i0} \) on stock \( i \) can be arbitrary, while the weights of investment for holding period months afterward are determined by the stock’s prior return history, on the assumption that any dividends paid are reinvested in the same stock during the portfolio holding period. We calculate and present in the empirical chapters two special cases of the initial investment at the beginning of the holding period:

i. If the portfolio is initially equally weighted, with \( \frac{M_{i0}}{\sum_{i=1}^{N} M_{i0}} = \frac{1}{N} \), then for the first month of the holding period, \( t = 1 \), the weight of investment \( w_{it} \) for stock \( i \) is \( \frac{1}{N} \). From month 2 onwards, the portfolio is not necessarily equally weighted, since the weights of investments on each stock is then determined by the stock return performance over the previous holding period months;

ii. If the portfolio is value-weighted at the beginning of the holding period, with the weight of initial investment based on the market values at the start of the first holding month, \( \frac{M_{i0}}{\sum_{i=1}^{N} M_{i0}} = \frac{MV_{i0}}{\sum_{i=1}^{N} MV_{i0}} \), then \( w_{it} = \frac{MV_{i0}}{\sum_{i=1}^{N} MV_{i0}} \); from month 2 onwards, the weights of investments \( w_{it} \) are equivalent to those determined by prior return history, with the condition that any dividends paid are reinvested in the same stock in the next month of the portfolio holding period. Hence value
weights do not give the same indication of the actual investor’s wealth as the stock performance determined by prior return history.

### 3.4.3.2 Risk-adjusted portfolio returns

To evaluate the performance of investment strategies, we need to measure the abnormal returns against a particular benchmark. Several approaches have been adopted in prior research for the estimation of expected abnormal returns/risk-adjusted returns. As discussed in the literature review chapter in section 2.3.2, we use the portfolio-matching method to calculate the risk-adjusted portfolio returns. This approach is to match each firm within the portfolio with a benchmark portfolio and the monthly abnormal return for this firm is the firm raw return less the matched benchmark portfolio return. The monthly portfolio abnormal return is then the weighted average of the monthly abnormal returns of each firm within the portfolio.

For each firm $i$, suppose the benchmark return using firm-matching technique is $r_{it}^b$, then the monthly risk-adjusted abnormal portfolio return $r_{pt}^a$ for portfolio $p$ in month $t$ is:

$$r_{pt}^a = \sum_{i=1}^{N} w_{it} (r_{it} - r_{it}^b)$$  \hspace{1cm} (3.28)

To obtain $r_{it}^b$, we match, at the date of portfolio formation, each individual firm with a benchmark portfolio that is considered as bearing similar risks. This portfolio matching technique is used to control for size effect or book-to-market effect, or both.
3.4.3.2.1 Benchmark portfolio: size-matching and/or BM-matching portfolios

Different benchmark portfolios are assumed to capture different risk factors, and benchmarks normally used in the literature are the return on the market (market-adjusted returns), the return on portfolio of firms of similar size (size-matched returns), the return on portfolios of firms with similar book-to-market ratio (book-to-market adjusted returns), or the return on portfolios of firms with similar combinations of size and book-to-market ratio (size and book-to-market adjusted returns). We use the latter three approaches in this study.

Benchmark portfolios are formed annually at the start of July by sorting the sample by size (market value), book to market value of equity (BM), or both (size and book-to-market). We follow most prior research and use the market value at the end of June to measure size (Gregory, Harris and Michou, 2001, Fletcher, 2001 and Fletcher and Forbes, 2002, Al-Horani, Pope and Stark, 2003 and Dimson, Nagel and Quigley, 2003), and the market value at the end of December of the previous year to calculate book-to-market ratio (Liu, Strong and Xu, 1999).

Taking the portfolios formed using error ratios generated for year 1996 and held from 1st July 1997 to 30th June 1998 as an example, the benchmark portfolio to control for any

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27 If the portfolios are formed with error ratio using 1996 accounting and market data and are held between 1st July 1997 to 30th June 1998, benchmark portfolios matched against these portfolios are formed accordingly on 1st July 1997, and are assumed to be held for twelve months till 30th June 1998. Firms with negative book-to-market ratio (due to negative book value of equity data) are excluded from the sorts.

28 There is ambiguity regarding the market value figure that is used in the calculation of book-to-market value, particularly for forming book-to-market benchmark portfolios. (Michou, Mouselli and Stark, 2007)
size effect is assumed to be held for the same holding period, and market value at the beginning of the holding period (30th June 1997) is used as a proxy for size to form size portfolios. For book-to-market sorted benchmark portfolios, the book-to-market ratio is calculated as book value reported for accounting year 1996 over market value on 31st December 1996.

Firms are sorted into ten size portfolios or ten BM portfolios to be matched against the sample portfolios. However, to form size and book-to-market portfolios, two sorting methods need to be used to create four-by-four benchmark portfolios to capture size and book-to-market effect at the same time.

3.4.3.2.2 Size and BM matching (independent sort and subsequent sort)


To illustrate the independent sorting method, at the end of June for each year $t$, firms are sorted into four groups, based on their market value by the end of June. Simultaneously, firms are also allocated in an independent sort to four BM groups. Sixteen size and book-to-market portfolios are created from the intersections of the four size and four BM groupings. The second sorting method is the subsequent sorting method where, for each
year \( t \), firms are sorted into four size groups first. Then, *within each size group*, stocks are sorted into four BM groups.

The main difference between these two sorting methods is the number of stocks allocated to each of the sixteen size and book-to-market portfolios. In other words, the subsequent sorting method can guarantee exactly the same number of stocks in each of the four portfolios within each size group, whereas this is not necessarily true for the independent sorting approach.

### 3.4.3.2.3 Monthly benchmark portfolio returns

Monthly returns for the portfolios are calculated for the 12 months from July of year \( t \) to June of year \( t+1 \). The monthly benchmark portfolio return in each holding period month is calculated using the initially value- and equally-weighted methods, in that holding-period month.\(^{29}\) \(^{30}\) These portfolio returns for the ten size portfolio, ten BM portfolio or sixteen size and book-to-market portfolios are the proxy for expected returns with size and B/M effects.

To match these benchmark portfolio return against each individual firm within the sample portfolio, suppose if firm \( i \) is located in the third size and book-to-market portfolio out of the sixteen portfolios, then if the average portfolio return for this particular benchmark portfolio is \( r_{u}^{b} \), this will be deducted from the return of firm \( i \),

\(^{29}\) Alternatively, the benchmark portfolio returns are also calculated as simply the mean return of constituent shares.  
\(^{30}\) We also calculate the benchmark portfolio returns as the arithmetic average of all individual stock returns within the holding period, and this has insignificant impact on the results.
$r_n$, to calculate the monthly risk-adjusted abnormal portfolio return $r_{pt}^a$, as indicated in formula (3.28) above.

3.4.3.3 Delisting stock treatment

So far we assume that each stock within the sample and benchmark portfolio has a complete return history during the 12-month holding period. Frequently, however, stocks are delisted from the stock market for various different reasons. For a stock delisted in the holding period, we adjust the stock return to -100% when the LSPD death type is liquidation (code 7), quotation cancelled for reason unknown (code 14), receiver appointed/liquidation (code 16), in administration (code 20), or cancelled and assumed valueless (code 21), and its post-delisting monthly returns are zero over the remaining holding period months. For firms delisted due to takeover (code 5), the proceeds from the stock delisted during a holding period month $t$ are assumed to be reinvested in the benchmark portfolio in month $t+1$, so that its post-delisting monthly abnormal return is zero after deducting the benchmark return.

3.5 Summary

In this chapter, the research methods of the two empirical studies are described. The first research study concerns the evaluation of various estimation specifications of firm valuation models. The purpose of this part of the study is to examine whether out-of-sample valuation errors can be used as an alternative metric to evaluate difference estimation specification of an extended firm valuation model in the UK. The results are reported in Chapter 5.
The second research question investigates if the extended valuation model can be used to form profitable portfolio investment strategies based on in-sample valuation errors; and portfolio performance assessment has been discussed in this chapter. The results of this study are presented in Chapter 6. In the next chapter, we will discuss the process of data collection and sample selection, as well as some initial results.
CHAPTER 4
DATA SAMPLING AND INITIAL RESULTS

4.1 Introduction

The purpose of this thesis is to evaluate cross-sectional corporate valuation models in the UK context. In chapter 3, we discuss the research methodology employed in this study. In order to investigate the issues of interest associated with UK corporate valuation models, accounting and market data of both live and dead UK listed companies are needed for model estimation purpose and for the calculation of valuation errors, whilst return data needs to be collected to measure the performance of the portfolios formed based on the firm valuation models. In this chapter, I describe the process of data collection and the measurement of the relevant variables. Section 4.2 identifies the steps followed in collecting the data for all non-financial UK companies. Section 4.3 identifies the procedure of data treatment. Section 4.4 presents the variable definitions. A brief summary is to be found in Section 4.5

4.2 Data and sampling

The sample for this study consists of all UK non-financial companies listed on the London Stock Exchange from 1990 to 2006. The sample data starts from 1990 when RD data becomes consistently available. Dead companies are included to avoid the presence of survivorship bias. Accounting data is from the Worldscope database, and market data
is from Datastream.\textsuperscript{31} As Datastream has undergone changes and is still undergoing significant changes since it’s taken over by Thomson-One-Banker, I feel it is important to emphasize the date of data collection, 25/04/2008, the data of which date is used as the basis of the whole data collection process, and for which all results in the following chapters are estimated.\textsuperscript{32}

4.2.1 The formation of the company list

In order to include both live and dead companies in the company list, I merge the ‘FBRIT’ list, ‘FBRIT’ being the mnemonic representing all companies currently listed on the London Stock Exchange (LSE), and the ‘DEADUK’ list, with ‘DEADUK’ being the mnemonic for all companies that used to be listed on LSE. Further, I merge ‘WSCOPEUK’ to the list to make sure that I include as many listed companies as possible in my list, and ‘WSCOPEUK’ is a constituent list created by WorldScope after the Thomson Corporation took over Datastream.

Using programme 900A at the date of collection, ‘FBRIT’ has 2308 firms, ‘DEADUK’ has 5740 firms and ‘WSCOPEUK’ has 4592 firms. After merging the three lists, and deleting duplicates, there are 8787 live and dead firms identified.

\textsuperscript{31} Returns are calculated from Datastream’s Return Index datatype using the following formula: \( r_{i,t} \text{RI}_i, t/ \text{RI}_i, t-1 \), where \( r_{i,t} \) is the return of stock \( i \) at month \( t \), and \( \text{RI}_i, t \) is the Return Index for stock \( i \) at month \( t \). The \( RI \) datatype in Datastream assumes dividend reinvestment.

\textsuperscript{32} Thomson-one-banker owns both Worldscope and Datastream database.
Table 4.1

Process of Extracting the Firms from Datastream

<table>
<thead>
<tr>
<th>Number of Firms</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial sample</strong></td>
</tr>
<tr>
<td>Firms’ currency is not available or is not £ (identified by CURRENCY)</td>
</tr>
<tr>
<td>Firms not traded in London (identified by EXMNEM)</td>
</tr>
<tr>
<td>Financial firms or industry sector cannot be identified (identified by ICBIN)</td>
</tr>
<tr>
<td>Total deletions</td>
</tr>
<tr>
<td><strong>Remaining sample</strong></td>
</tr>
</tbody>
</table>

Table 4.1 shows the impact of various data restrictions on the sample. Deleting 301 firms with no currency information or the currency is not identified as British sterling pounds reduces the sample to 8486 firms. Using EXMNEM, 84 firms are identified as not trading on the London Stock Exchange and are removed from the sample. There are 3240 firms identified as either unclassified, unquoted, suspended or financial companies using the ICBIN industry classification code. This gives me a remaining sample of 5162 firm identification codes to proceed to the process of collecting both accounting and market data.

4.2.2 Data collection

Data for this study are collected from Worldscope and Datastream, with accounting data (including financial year end date) using the 900C programme and market data (monthly
market value and stock return) using the 900B programme. Annual accounting data is collected and arranged from 1990 to 2007, year by year separately, and is merged with pretreated market data using SAS.

4.2.2.1 Treatment of Datastream market data

For firms that are no longer listed, Datastream leaves the market value for all months after the delisting month the same as the delisting month’s market value. This can cause problems for my analysis because I need to retrieve market value six months after the financial year end date and twelve months of market and return data after the portfolio formation date for the portfolio strategies. These dead firms will appear alive if for this problem raw Datastream market data is left untreated.

To treat this particular problem with Datastream market data, I use the TIME variable from Datastream, which is provided by Datastream to provide a date when the database received the last price update for a listed stock. The month information of TIME is used to determine the delisting month. This process gives a reasonable event time when the share stopped trading on the market. Additionally, as Datastream does not provide information regarding companies’ delisting reasons, the 2006 London Share Price Database (LSPD) is used to complement this information, following prior literature (Liu, Strong and Xu, 2003). G10 (Type of Death) from the L2006G file of LSPD is a coded variable to provide “an indication of the reason why the security ceased to be quoted”

900C programme is for data collection of cross-sectional data and 900B for time series data in Datastream Windows platform.
(L2006man, p7), and the illustration table is retrieved from the LSPD manual file and presented in Table 4.2 below:

**Table 4.2**

**L2006man - G10 Type of Death**

<table>
<thead>
<tr>
<th>G10 code</th>
<th>Type of Death</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Acquisition/takeover/merger</td>
</tr>
<tr>
<td>6</td>
<td>Suspension/cancellation with shares acquired later. Meanwhile maybe traded under rule 163(2)*</td>
</tr>
<tr>
<td>7</td>
<td>Liquidation (usually valueless, but there may be liquidation payments)</td>
</tr>
<tr>
<td>8</td>
<td>Quotation cancelled (maybe suspended initially) as company becomes a private company, or there is insufficient trading in the shares. Dealing continue under rule 163 (2) or (3)*</td>
</tr>
<tr>
<td>9</td>
<td>As for 8, but no dealings under rule 163</td>
</tr>
<tr>
<td>10</td>
<td>Quotation suspended – if suspended for more than three years, this may lead to automatic cancellation</td>
</tr>
<tr>
<td>11</td>
<td>Voluntary liquidation, where value remains and was / is being distributed</td>
</tr>
<tr>
<td>12</td>
<td>Changed to foreign registration</td>
</tr>
<tr>
<td>13</td>
<td>Quotation cancelled for reason unknown. Dealings continue under rule 163(2) or (3)*</td>
</tr>
<tr>
<td>14</td>
<td>As for 13, but no dealings under rule 163*</td>
</tr>
<tr>
<td>15</td>
<td>Converted into an alternative security for the same company</td>
</tr>
<tr>
<td>16</td>
<td>Receiver appointed/liquidation. Probably valueless, but not yet certain</td>
</tr>
<tr>
<td>17</td>
<td>Unitisation of an investment or financial trust</td>
</tr>
<tr>
<td>18</td>
<td>Nationalisation</td>
</tr>
<tr>
<td>19</td>
<td>Enfranchisement</td>
</tr>
<tr>
<td>20</td>
<td>In Administration/Administrative receivership</td>
</tr>
<tr>
<td>21</td>
<td>Cancelled and assumed valueless</td>
</tr>
</tbody>
</table>

*Note: Historically, quite a few companies delisted from the London Stock Exchange because of insufficient trading, but some of them continued to be traded by the London Stock Exchange brokers on a matched bargain basis. This was known as Rule 163. This practice stopped, at least as a formal London Stock Exchange rule, at the time of the Big Bang (London Stock Exchange reform) in 1986.
To correct the Datastream market data, if the delisting reason, coded by G10, is 7, 14, 16, 20 or 21, the return for the delisting month (determined by TIME) is set as -1 (as an investor would virtually lose all his/her investment under these particular delisting scenarios) and the market value is set to nil on and after the delisting month. For all the other delisting reasons, it is assumed that the monthly return retrieved from Datastream is the return for the delisting month, and any returns after the delisting month are set to nil; further, the market value for the delisting month and following months is set to nil, since the market value for the delisting month is later used in the analysis as the opening market value for the month after.

### 4.2.2.2 Accounting data

The annual accounting data is then merged and lined up with the treated market data, as I need to retrieve the market value six months after the financial year end date to be used as market value of equity for the valuation model estimation process. So for the portfolio strategies, the firm needs to have the opening market value and return data for at least the first month of the specific twelve-month holding period (for instance, for the year 1990 sample, the holding period is from 1 July 1991 to 30 June 1992). The merged dataset is arranged annually to be sorted and treated according to the specific requirements of the studies.

First, the merged annual data are sorted by closing book value and then earnings, and firms with missing data are deleted from the sample, which gives an initial sample constituted of firms with both book value and earnings data available before any further data restriction steps. Second, I convert the annual files from SAS into spreadsheets, and
sample firms are sorted by COMNAME (company name) and then I manually identify and delete the firms with dual or multiple classes of quoted shares (i.e., two or more stocks with different DSCD (Datastream identification code) and different market value time series data, while having the same company name and the same accounting data for a particular financial year). These firms with dual or multiple classes of shares will distort the sample since each DSCD is assumed to represent a single firm so that the market value is representing the firm’s market capitalization equivalently across all firms within the sample. Therefore, these particular DSCD are removed from the sample (i.e., all dual or multiple quoted shares associated with the same company are deleted).

Third, as the investigation tends to focus on the valuation of common shares, firms that issue significant amount of non-quoted preference shares are also removed from the sample, specifically companies whose ratio of preference share equity (WC03451) to shareholders’ equity (WC03995) is higher than 10%. Last but not the least, firms with negative book value of equity are deleted, since closing book value will be used as one of the deflators. Additionally, all missing variables, such as research and development expenditure, dividends, capital contribution and capital expenditure, are set to be zero, where it is assumed that if a firm chooses not to report a particular accounting amount, it is equal to zero.
### Table 4.3

Process of Cleaning the Sample

<table>
<thead>
<tr>
<th>YEAR</th>
<th>No. of Obs. after deleting firms without BV or E</th>
<th>No. of Obs. after deleting firms with Dual/Multiple classes of shares</th>
<th>No. of Obs. after deleting firms with significant amount of preference shares</th>
<th>No. of Obs. after deleting negative BV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>1459</td>
<td>1321</td>
<td>1200</td>
<td>1176</td>
</tr>
<tr>
<td>1991</td>
<td>1490</td>
<td>1348</td>
<td>1223</td>
<td>1190</td>
</tr>
<tr>
<td>1992</td>
<td>1491</td>
<td>1347</td>
<td>1212</td>
<td>1171</td>
</tr>
<tr>
<td>1993</td>
<td>1514</td>
<td>1368</td>
<td>1235</td>
<td>1192</td>
</tr>
<tr>
<td>1994</td>
<td>1564</td>
<td>1416</td>
<td>1281</td>
<td>1241</td>
</tr>
<tr>
<td>1995</td>
<td>1577</td>
<td>1431</td>
<td>1307</td>
<td>1255</td>
</tr>
<tr>
<td>1996</td>
<td>1890</td>
<td>1744</td>
<td>1593</td>
<td>1516</td>
</tr>
<tr>
<td>1997</td>
<td>1987</td>
<td>1850</td>
<td>1694</td>
<td>1603</td>
</tr>
<tr>
<td>1998</td>
<td>1918</td>
<td>1780</td>
<td>1649</td>
<td>1555</td>
</tr>
<tr>
<td>1999</td>
<td>1830</td>
<td>1690</td>
<td>1573</td>
<td>1490</td>
</tr>
<tr>
<td>2000</td>
<td>1865</td>
<td>1723</td>
<td>1634</td>
<td>1568</td>
</tr>
<tr>
<td>2001</td>
<td>1908</td>
<td>1781</td>
<td>1689</td>
<td>1604</td>
</tr>
<tr>
<td>2002</td>
<td>1975</td>
<td>1854</td>
<td>1733</td>
<td>1592</td>
</tr>
<tr>
<td>2003</td>
<td>2058</td>
<td>1939</td>
<td>1803</td>
<td>1597</td>
</tr>
<tr>
<td>2004</td>
<td>2134</td>
<td>2021</td>
<td>1898</td>
<td>1706</td>
</tr>
<tr>
<td>2005</td>
<td>2158</td>
<td>2047</td>
<td>1937</td>
<td>1781</td>
</tr>
<tr>
<td>2006</td>
<td>2094</td>
<td>1991</td>
<td>1900</td>
<td>1779</td>
</tr>
<tr>
<td><strong>Total Sample</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>25016</strong></td>
</tr>
</tbody>
</table>
4.2.2.3 Retrieving market value

For convenience of data collection, and given that with the closing market value is defined as the market value six months after, with the opening market value six months before, the financial year end (FYE) date, irregular FYE dates are treated. Although most companies follow conventional choices and use the end of March, April, June and December as their FYE date, there are some companies choosing to use odd dates such as 19/02 or 13/07. Taking the year 1990 as an example of standardizing the FYE date for retrieval of market value data, first, companies that do not have the financial year end date data for year 1990 are excluded from the sample. Second, if Datastream gives a firm’s FYE date in the sample of 1990 as in early January of 1991, then its FYE is set as December 31, 1990, and closing market value will be six month after December 1990 (i.e., 30/06/1991), for this particular firm. If the FYE date of a firm is between the 1st and 15th of a month, for instance, April, then its FYE is set to be March 31, and as a consequence, its closing market value will be measured six month after March 31 (i.e., 30/09/1991); If the FYE date is between the 16th and 30th or 31st of April, then its FYE is treated as April 30, and closing market value on 31/10/1991 will be retrieved for this firm. In some rare cases, the firm is delisted within six months after its FYE date, and since its closing market value cannot be retrieved, these firms are deleted from the sample as well.
4.2.3 Deletion of outliers

“Extreme values can cause problems in least squares regression in the sense that they will significantly affect the values of the estimated coefficients. In this study, the data is initially trimmed. Hence, observations in the top and bottom 0.5% according to their values for the deflated values of MV/Def, E/Def, OI/Def, as well as the deflated constant term (1/Def), are considered as extreme values and, therefore, removed from the sample. There are a great number of zero observations for variables such as research and development expenditures (RD/Def), dividends (D/Def), capital contribution (CC/Def) and capital expenditures (CE/Def), however. For these four variables, assuming all observations are sorted from top to bottom with the lowest values at the bottom, it makes little sense to identify the bottom 0.5% companies because all the bottom 0.5% observations carry the value of zero. Therefore, for these four particular deflated variables, only the top 0.5 % company years are removed as extreme observations. This type of deletion criterion is a procedure frequently used in market-based accounting research (Easton and Harris, 1991, Strong and Walker 1993, Akbar and Stark 2003a and 2003b, among others).

The deletion procedure, together with the estimation of OI, is carried out as follows. To estimate the valuation equation for the year 1991, first, all the observations with data

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34 To ensure the sample includes as many firm observations as possible, when a firm does not disclose accounting information such as research and development, dividends, capital contribution and capital expenditure, it is assumed that these items are zero and, hence, these variables are set to be zero for these firms.
Second, the deflated version of the firm valuation model is estimated with the trimmed data for 1990 to generate estimated coefficients, which are then applied to the untrimmed data of 1990 to obtain the estimate of $OI$ for 1991 which, as discussed previously, is a function of the error term of the estimated regression for 1990. The $OI$ generated using 1990 data are then carried forward to 1991 and merged with the untrimmed observations available for 1991. Finally, for the complete set of 1991 data, the trimming process is repeated and the deflated valuation equation is estimated using the trimmed data for 1991. These principles are similarly carried out when dealing with different model specifications. When splitting the full sample into high and low-intangible assets firms separately, we simply split the trimmed data for 1991 using the market-to-book ratio. These processes are then applied to all years.

Table 4.4 shows the outcomes of the process of merging and estimating $OI$ on a year-by-year basis, in terms of sample sizes, when the model is deflated by closing book value. The final sample of firm-years when $SALES$ is used as deflator is 16160, when number of shares is used as deflator, the final sample is reduced to 16634, and with opening market value as deflator, 15568.

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35 The example here is based on the valuation model that includes $OI$, which is estimated using previous year’s regression error term, and hence, to estimate the valuation equation of 1991, the outlier deletion process starts from the 1990 sample.
### Table 4.4

**Firm-years – Final Sample**

*-- BV deflated --*

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Untrimmed Sample of Year t</th>
<th>After deleting firms without MV data</th>
<th>No. of Obs. Trimmed</th>
<th>Final sample without OI After trimming</th>
<th>After merged with Year t+1 data</th>
<th>No. of Obs. Trimmed</th>
<th>Final sample with OI for Year t+1 After trimming</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>1176</td>
<td>1037</td>
<td>35</td>
<td>1002</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1991</td>
<td>1190</td>
<td>1042</td>
<td>34</td>
<td>1008</td>
<td>988</td>
<td>36</td>
<td>952</td>
</tr>
<tr>
<td>1992</td>
<td>1171</td>
<td>1006</td>
<td>37</td>
<td>969</td>
<td>972</td>
<td>40</td>
<td>932</td>
</tr>
<tr>
<td>1993</td>
<td>1192</td>
<td>1020</td>
<td>34</td>
<td>986</td>
<td>944</td>
<td>35</td>
<td>909</td>
</tr>
<tr>
<td>1994</td>
<td>1241</td>
<td>1061</td>
<td>33</td>
<td>1028</td>
<td>961</td>
<td>32</td>
<td>929</td>
</tr>
<tr>
<td>1995</td>
<td>1255</td>
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<td>35</td>
<td>1032</td>
<td>997</td>
<td>38</td>
<td>959</td>
</tr>
<tr>
<td>1996</td>
<td>1516</td>
<td>1249</td>
<td>43</td>
<td>1206</td>
<td>985</td>
<td>36</td>
<td>949</td>
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<td>1997</td>
<td>1603</td>
<td>1334</td>
<td>54</td>
<td>1280</td>
<td>1139</td>
<td>44</td>
<td>1095</td>
</tr>
<tr>
<td>1998</td>
<td>1555</td>
<td>1281</td>
<td>37</td>
<td>1244</td>
<td>1175</td>
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<td>1139</td>
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<td>1999</td>
<td>1490</td>
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<td>42</td>
<td>1157</td>
<td>1072</td>
<td>37</td>
<td>1035</td>
</tr>
<tr>
<td>2000</td>
<td>1568</td>
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<td>53</td>
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<td>1044</td>
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<td>995</td>
</tr>
<tr>
<td>2001</td>
<td>1604</td>
<td>1365</td>
<td>57</td>
<td>1308</td>
<td>1141</td>
<td>56</td>
<td>1085</td>
</tr>
<tr>
<td>2002</td>
<td>1592</td>
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<td>1125</td>
</tr>
<tr>
<td>2003</td>
<td>1597</td>
<td>1257</td>
<td>44</td>
<td>1213</td>
<td>1165</td>
<td>46</td>
<td>1119</td>
</tr>
<tr>
<td>2004</td>
<td>1706</td>
<td>1373</td>
<td>59</td>
<td>1314</td>
<td>1131</td>
<td>49</td>
<td>1082</td>
</tr>
<tr>
<td>2005</td>
<td>1781</td>
<td>1524</td>
<td>64</td>
<td>1460</td>
<td>1226</td>
<td>49</td>
<td>1177</td>
</tr>
<tr>
<td>2006</td>
<td>1779</td>
<td>1575</td>
<td>58</td>
<td>1517</td>
<td>1346</td>
<td>58</td>
<td>1288</td>
</tr>
<tr>
<td></td>
<td><strong>Total Sample</strong></td>
<td><strong>25016</strong></td>
<td></td>
<td><strong>20250</strong></td>
<td><strong>16770</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.3  Variable measurement

The definitions of the variables are presented as follows (variable definitions extracted from the database are presented in Appendix 1):

1. $MV_t$ - market value for a firm of a given calendar year $t$, is measured six months after the date of its balance sheet. All firms with their balance sheet date within 1990 will be considered to be within the same calendar year. For a firm whose financial year is considered to end on December 31, 1990, its market value will be measured on June 30, 1991, or the nearest trading day. The reason for doing this is that all UK listed firms have six months to prepare and release their annual accounts. Accordingly, the market value six months after the balance sheet date is used to help ensure that the information in the financial statement for a given financial year is reflected in the market price (Datastream item MV);

2. $BV_t$ - closing book value at year $t$ is measured as shareholder’s equity at year $t$ (Worldscope item - WC03995 - Total Shareholder’s Equity);

3. $E_t$ - earnings at year $t$, are measured as net income before preferred dividends at year $t$ (Worldscope item - WC01651 - Net Income Available to Common);

4. $RD_t$ - research and development expenditures at year $t$ are measured as RD expenses recognized in the income statement at year $t$ (Worldscope item - WC01201- Research and Development Expense);

5. $D_t$ - dividends at year $t$ are measured as the total cash common dividends paid on the company’s common stock during year $t$ (Worldscope item - WC05376 - Common Dividends cash);
6. \( CC_t \) - capital contributions at year \( t \) are measured as the negative of the amount a company received from the sale of common and/or preferred stock at year \( t \) (Worldscope item - \( WC04251 \) - Net Proceeds from Sales/Issue of Common and Preferred); 

7. \( CE_t \) - capital expenditures at year \( t \) are measured as the funds used to acquire fixed assets other than those associated with acquisitions at year \( t \) (Worldscope item - \( WC04601 \) - Capital Expenditures – Additions to Fixed Assets); 

8. \( S_t \) - deflators where, further, \( Sales \) is measured by as gross sales and other operating revenue less discounts, returns and allowances (Worldscope item \( WC01001 \), Net Sales or Revenues); \( NoShares \), number of shares, is measured by common shares outstanding (Worldscope item \( WC05301 \), Common Shares Outstanding); 

### 4.4 Sample characteristics

As shown in table 4.4 above, each annual cross section (without \( OI \)) has between 969 and 1517 firm observations, while the annual samples (with \( OI \)) has between 909 and 1288 firm observations.

Tables 4.5 below shows some characteristics of deflated variables used in the regression models for the various pooled samples (without and with \( OI \) respectively). First, \( CC \) is the negative amount of capital contribution, which should have the same sign convention to \( D \) – hence, a negative number implies an increase of capital. Second, sample statistics for \( BV \) are not provided when BV is itself the deflator. Consistent with the sample
characteristics of Akbar and Stark (2003a), all the deflated variables show signs of skewness (as captured by the difference between mean and median values).

We observe that there are still some extreme observations after trimming. To mitigate against problems of measurement error, the remaining extreme observations are randomly sampled and carefully checked against the actual company annual reports. No measurement errors are detected from this random check. We then follow a prior study (Green, Stark and Thomas, 1996) and additionally remove firms for which the market-to-book ratio is greater than 10. This does not solve, however, the problem of extreme observations, given subsequently produced (untabulated) descriptive statistics. Further, the regression results are largely consistent with and without further attempts at deleting extreme observations.

We should emphasize, however, that this study does not draw inferences directly from estimated coefficients. Also, the annual trimmed samples are successively pooled together to generate estimated coefficients, with the estimated coefficients generated from the successive trimmed samples then applied to untrimmed samples when valuation errors are calculated (as described in detail in the previous chapter). Given the focus is to evaluate different model specifications and, hence, remaining outliers can potentially bias the coefficients of all model specifications tested, they should not have a great impact on our conclusions. As a consequence, the remaining extreme observations are left in the sample.

Nonetheless, alternative trimming strategies could have been an added dimension to the exploration of estimation approaches that takes place in the study. To have added this
dimension, however, would have added considerably to the complexity of the analysis. Nonetheless, within a focus on the evaluation of different model specifications and estimation processes, we choose to hold the trimming strategy constant and consistent with practices in previous research. As a consequence, its exploration is left for future research.
<table>
<thead>
<tr>
<th></th>
<th>MV</th>
<th>BV</th>
<th>E</th>
<th>RD</th>
<th>D</th>
<th>CC</th>
<th>CE</th>
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<tr>
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<tr>
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<td>0.00</td>
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<tr>
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<td>0.02</td>
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</tr>
<tr>
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<td>n.a.</td>
<td>0.69</td>
<td>0.12</td>
<td>0.07</td>
<td>0.39</td>
<td>0.19</td>
</tr>
<tr>
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<td></td>
<td></td>
</tr>
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<td>1.60</td>
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<td>0.02</td>
<td>-0.61</td>
<td>0.12</td>
</tr>
<tr>
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<td>0.41</td>
<td>0.04</td>
<td>0.00</td>
<td>0.01</td>
<td>0.00</td>
<td>0.04</td>
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<td>397.63</td>
<td>1.73</td>
<td>32.93</td>
<td>0.55</td>
<td>0.04</td>
<td>23.21</td>
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<tr>
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<td>9.04</td>
<td>3.17</td>
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<td>0.03</td>
<td>7.21</td>
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<td><strong>Number of Shares as Deflator</strong></td>
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<td>0.08</td>
<td>-0.09</td>
<td>0.24</td>
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<td>0.63</td>
<td>0.06</td>
<td>0.00</td>
<td>0.02</td>
<td>0.00</td>
<td>0.06</td>
</tr>
<tr>
<td>Maximum</td>
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<td>431.65</td>
<td>38.66</td>
<td>22.37</td>
<td>7.97</td>
<td>0.01</td>
<td>66.88</td>
</tr>
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<td>Minimum</td>
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<td>0.00</td>
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<td>0.00</td>
<td>0.00</td>
<td>-21.85</td>
<td>0.00</td>
</tr>
<tr>
<td>Std Dev</td>
<td>5.69</td>
<td>6.23</td>
<td>1.07</td>
<td>0.35</td>
<td>0.24</td>
<td>0.50</td>
<td>1.09</td>
</tr>
<tr>
<td><strong>Opening Market Value as Deflator</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>1.19</td>
<td>0.83</td>
<td>0.00</td>
<td>0.02</td>
<td>0.03</td>
<td>-0.06</td>
<td>0.10</td>
</tr>
<tr>
<td>Median</td>
<td>1.05</td>
<td>0.54</td>
<td>0.05</td>
<td>0.00</td>
<td>0.02</td>
<td>0.00</td>
<td>0.05</td>
</tr>
<tr>
<td>Maximum</td>
<td>22.85</td>
<td>221.56</td>
<td>12.90</td>
<td>11.47</td>
<td>4.61</td>
<td>0.02</td>
<td>31.94</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.02</td>
<td>0.01</td>
<td>-4.48</td>
<td>0.00</td>
<td>0.00</td>
<td>-4.15</td>
<td>0.00</td>
</tr>
<tr>
<td>Std Dev</td>
<td>0.84</td>
<td>2.85</td>
<td>0.32</td>
<td>0.15</td>
<td>0.08</td>
<td>0.17</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Table 4.5
Descriptive Statistics for the Pooled Samples

*Panel A – Sample without OI*
### Panel B - Sample with OI

#### MV BV E RD D NEGCC CE OI

<table>
<thead>
<tr>
<th></th>
<th>Closing Book Value as deflator</th>
<th>Sales as Deflator</th>
<th>Number of Shares as Deflator</th>
<th>Opening Market Value as Deflator</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N 16770</td>
<td>N 16160</td>
<td>N 16634</td>
<td>N 15568</td>
</tr>
<tr>
<td>Mean</td>
<td>2.97 n.a.</td>
<td>2.48 0.99</td>
<td>2.80 1.67</td>
<td>1.2 0.82</td>
</tr>
<tr>
<td>Median</td>
<td>1.83 n.a.</td>
<td>0.81 0.41</td>
<td>1.34 0.67</td>
<td>1.07 0.57</td>
</tr>
<tr>
<td>Maximum</td>
<td>220.68 n.a.</td>
<td>615.71 206.57</td>
<td>106.85 297.76</td>
<td>21.97 142.18</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.00 n.a.</td>
<td>0.00 -18.24</td>
<td>0.00 0.00</td>
<td>0.02 0.01</td>
</tr>
<tr>
<td>Std Dev</td>
<td>4.69 n.a.</td>
<td>12.23 3.49</td>
<td>4.87 4.83</td>
<td>0.78 2.08</td>
</tr>
</tbody>
</table>

- **Closing Book Value as deflator**
  - N: 16770
  - Mean: 2.97, Median: 1.83, Maximum: 220.68, Minimum: 0.00, Std Dev: 4.69
- **Sales as Deflator**
  - N: 16160
  - Mean: 2.48, Median: 0.81, Maximum: 615.71, Minimum: 0.00, Std Dev: 12.23
- **Number of Shares as Deflator**
  - N: 16634
  - Mean: 2.80, Median: 1.34, Maximum: 106.85, Minimum: 0.00, Std Dev: 4.87
- **Opening Market Value as Deflator**
  - N: 15568
  - Mean: 1.2, Median: 1.07, Maximum: 21.97, Minimum: 0.02, Std Dev: 0.78
4.5 Initial regression results

4.5.1 Regression results without OI

To benchmark the extended model on the current sample against prior research, the cross-sectional regression results are reported for the annual and pooled sample without OI in Table 4.6 below, for four of the five deflators considered in the overall study. No results are reported using market value as the deflator as little benchmarking evidence on the value relevance of various accounting items is available for the UK. Following the Fama and MacBeth (1973) approach, we report the averages of annual coefficients, the significances of which are based on the standard deviation of the time series of annual coefficients.

Consistent with prior findings, the coefficient of D, dividends, is generally positive and significantly different from zero for three out of four deflators, for most years. The annual regression results are included in the Appendix 2, which show that, when using sales as a deflator, the coefficients of dividends are positively associated with the dependent variable, market value, for all early years of the sample period (prior 2000), and the coefficients switch signs for a few of the recent years. Considering that Akbar and Stark (2003a) covers the period from 1991 to 2001, our results are still broadly consistent with their findings.

Some discussions in this section are taken from the paper Dedman, Mouselli, Shen and Stark (2009), of which I am a co-author.
The coefficient of CC, capital contributions, is always negative and significantly different from 0, whatever the deflator. The coefficient of RD, research and development expenditure, is positively associated with market value for all four deflators and, for two out of the four deflators, the association is significant.

Further, we add another accounting variable, CE, capital expenditure, to the firm valuation model used in Akbar and Stark (2003a), and the coefficient of CE is found to be positive for three out of the four deflators, the exception being when number of shares is used as deflator. The latter result is not consistent with Rees (1997), who uses number of shares as a deflator.

Table 4.6

Fama-Macbeth Coefficients* from Annual Regressions of Market Value on Book Value (BV), Earnings (E), Research and Development Expenditures (RD), Dividends (D), Capital Contributions (CC) and Capital Expenditures (CE) for the Years 1990 to 2006

<table>
<thead>
<tr>
<th>Constant</th>
<th>BV</th>
<th>E</th>
<th>RD</th>
<th>DIV</th>
<th>CC</th>
<th>CE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closing Book Value (BV) as a deflator</td>
<td>4478.98</td>
<td>0.87</td>
<td>0.96</td>
<td>7.37</td>
<td>13.33</td>
<td>-3.28</td>
</tr>
<tr>
<td></td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Sales (SALES) as a deflator</td>
<td>3740.18</td>
<td>0.90</td>
<td>-1.26</td>
<td>12.04</td>
<td>7.84</td>
<td>-1.20</td>
</tr>
<tr>
<td></td>
<td>0.00</td>
<td>0.03</td>
<td>0.15</td>
<td>0.00</td>
<td>0.23</td>
<td>0.01</td>
</tr>
<tr>
<td>Number of Shares (NoSHARES) as a deflator</td>
<td>5014.80</td>
<td>0.33</td>
<td>1.17</td>
<td>3.76</td>
<td>7.40</td>
<td>-2.96</td>
</tr>
<tr>
<td></td>
<td>0.00</td>
<td>0.01</td>
<td>0.01</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Opening Market Value (OMV) as a deflator</td>
<td>2920.50</td>
<td>0.30</td>
<td>0.42</td>
<td>2.71</td>
<td>5.38</td>
<td>-1.85</td>
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<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

* p-value to two decimal places in italics.
4.5.2 Regression results when including OI in the estimation model

The inclusion of OI, other information, improves the significance of the regression results, and make the major findings more consistent with prior studies. First, other information, OI, is estimated using the methods suggested in Akbar and Stark (2003a) and, consistent with their findings, the coefficient of OI is always positive and significantly different from 0, and this result is robust to the choice of deflator.

Second, the coefficient of $D$, dividends, is positive and significantly different from 0 for all four deflators. The coefficient of $CC$, capital contributions, is always negative and significantly different from zero, and this result is robust to the choice of deflator. The coefficient of $RD$, research and development expenditures, is positively associated with market value, although the coefficient size is notably smaller if either number of shares or opening market value are used as deflator relative to if either book value or sales are used. Also the majority of the results of the annual cross-sections show a positive association, except for the early years of the sample, which is consistent with the idea that market values reflect RD capital (Dedman, Mouselli, Shen and Stark, 2009). Further, the coefficient of $CE$ is now found to be positive and significant for all four deflators,
Table 4.7

Fama-Macbeth Coefficients* from Annual Regressions of Market Value on Book Value (BV), Earnings (E), Research and Development Expenditures (RD), Dividends (D), Capital Contributions (CC), Capital Expenditures (CE) and “Other Information (OI) for the Years 1990 to 2006

<table>
<thead>
<tr>
<th>Constant</th>
<th>BV</th>
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<th>DIV</th>
<th>CC</th>
<th>CE</th>
<th>OI</th>
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<td>4804.00</td>
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<td>6.75</td>
<td>13.47</td>
<td>-0.61</td>
<td>2.89</td>
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<td>0.00</td>
<td>0.00</td>
<td>0.71</td>
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<td>0.00</td>
<td>0.02</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Sales (SALES) as a deflator</strong></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>4521.10</td>
<td>0.80</td>
<td>-0.74</td>
<td>8.99</td>
<td>9.39</td>
<td>-1.10</td>
<td>1.99</td>
<td>0.63</td>
</tr>
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<td>0.00</td>
<td>0.01</td>
<td>0.07</td>
<td>0.00</td>
<td>0.00</td>
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<td><strong>Number of Shares (NoSHARES) as a deflator</strong></td>
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<tr>
<td>5972.70</td>
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<td>0.71</td>
<td>3.16</td>
<td>7.77</td>
<td>-1.82</td>
<td>0.97</td>
<td>0.77</td>
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<td>0.01</td>
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<tr>
<td>3870.70</td>
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<td>0.00</td>
<td>0.00</td>
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</tbody>
</table>

* p-value to two decimal places in italics.

Perhaps the major challenge to the economic credibility of the results reported in tables 4.6 and 4.7 is that the coefficient of earnings is low, and often insignificant, and the coefficient of dividends is positive, large, and significant. This is despite the fact that these results are consistent with prior UK empiricism (such as Akbar and Stark, 2003a).

Three possibilities have been advanced for this result in prior literature. First, it could occur because dividends capture the impact of permanent earnings, leading to a high coefficient for dividends, leaving earnings to only capture the impact of transitory earnings, leading to a low coefficient for earnings (Giner and Rees, 1999). Second,
Dedman, Kungwal and Stark (2010), related to the explanation put forward by Giner and Rees (1999), suggest that the reason that dividends have a positive coefficient is because they are informative about the level and persistence of future earnings. They find this to be true for pooled samples of all firms, profit firms, all dividend paying firms, and dividend paying profit firms.

Third, it could be an artefact of pooling profit and loss firms. In this respect, Jiang and Stark (2009b) find that, when profit and loss firms are separated, the coefficient of dividends is much lower, although positive and significant, for both sets of firms, relative to when the coefficient is estimated on the pooled sample. Further, the coefficient of earnings is much higher for profit firms, relative to when it is estimated on the pooled sample and, in particular, the coefficient is substantially higher than that for dividends. The coefficient of earnings for loss firms is not significantly different from zero. This suggests that, for profit firms, earnings, on average, carry information about future earnings, whereas earnings are not informative for loss firms. Nonetheless, dividends still appear able to explain market values over and above earnings for profit firms.

Investigating the bias and accuracy of the valuation models in this context suggests that it might be important to distinguish between profit and loss firms and estimate valuation models separately on these two groups. This issue is investigated in Chapter 5.
4.6 Summary

This chapter describes the process of data collection and sample selection. Variable definitions and some sample characteristics are also presented and discussed. To make our results comparable to prior studies, some initial regression results are presented in this chapter to benchmark against Akbar and Stark (2003a) in particular, to make sure that the difference between databases will not affect the inferences drawn from our empirical results. In the next two chapters, empirical results and analysis are presented and discussed.
Appendix 1  Variable definition – Extracts from WorldScope database

**BV  (WC03995)  Total Shareholders' Equity**
Definition: Total Shareholders' Equity

**E  (WC01651)  Net Income Before Preferred Dividends (Net Income Available To Common)**
Definition: Income Data, All Industries:
NET INCOME - BOTTOM LINE represents income after all operating and non-operating income and expense, reserves, income taxes, minority interest and extraordinary items.

**RD  (WC01201)  Research & Development Expense**
Definition: Worldscope Item Name: RESEARCH AND DEVELOPMENT EXPENSE
RESEARCH AND DEVELOPMENT EXPENSE represents all direct and indirect costs related to the creation and development of new processes, techniques, applications and products with commercial possibilities.
These costs can be categorized as:
1. Basic research
2. Applied research
3. Development costs of new products
It includes:
(1) Software Expense
(2) Amortization of Software Expense
(3) Design and Development Expense
It excludes:
(1) Customer or government sponsored research
(2) For oil, gas, coal, drilling and mining companies, purchase of mineral rights
(3) Engineering Expense
(4) Contributions by government, customers, partnerships or other corporations to the company's research and development expense
**D (WC05376) Common Dividends (Cash)**

Definition: Worldscope Item Name: COMMON DIVIDENDS (CASH)

Stock Data, All Industries:

COMMON DIVIDENDS CASH represent the total cash common dividends paid on the company's common stock during the fiscal year, including extra and special dividends. If the company has ESOP preferred stock, the dividends paid will be the full amount shown on the cash flow.

It excludes:

(1) Dividends paid to minority shareholders

Footnote Codes:

C. Includes dividend on treasury stock
D. Cash preferred dividend may be included
F. Dividend not paid on all shares
G. Includes tax credit on common dividend

**CC (WC04251) Net Proceeds From Sale Or Issue Of Common & Preferred**

Definition: Worldscope Item Name: NET PROCEEDS FROM SALE/ISSUE OF COMMON & PREFERRED

Cash Flow Data, All Industries:

SALE OF COM AND PFD STK CDF STMT represents the amount a company received from the sale of common and/or preferred stock. It includes amounts received from the conversion of debentures or preferred stock into common stock, exchange of common stock for debentures, sale of treasury shares, shares issued for acquisitions and proceeds from stock options.

Footnote Codes:

A. Includes proceeds from stock options
B. Includes long term borrowings

**CE (WC04601) Capital Expenditures (Additions To Fixed Assets)**

Definition: Worldscope Item Name: CAPITAL EXPENDITURES (ADDITIONS TO FIXED ASSETS)

Cash Flow Data, All Industries:
CAPITAL EXPENDITURES CF STMT represent the funds used to acquire fixed assets other than those associated with acquisitions.

It includes:

(1) Additions to property, plant and equipment
(2) Investments in machinery and equipment

Sales (WC01001) Net Sales Or Revenues
Definition: Worldscope Item Name: NET SALES OR REVENUES
Income Data, Industrial Companies:
NET SALES OR REVENUES represent gross sales and other operating revenue less discounts, returns and allowances.

NoShares (WC05301) Common Shares Outstanding
Definition: Worldscope Item Name: COMMON SHARES OUTSTANDING
Stock Data, All Industries:
COMMON SHARES OUTSTANDING represent the number of shares outstanding at the company's year end. It is the difference between issued shares and treasury shares. For companies with more than one type of common/ordinary share, common shares outstanding represents the combined shares adjusted to reflect the par value of the share type identified in field 6005 - Type of Share.
Appendix 2 Coefficients from Annual Regressions of Model without OI for the Years 1990 to 2006

**Panel A - Closing Book Value (BV) as a deflator**

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**Note:** The above tables show the regression results of the coefficients for the cross sectional data from year 1990 to year 2006. Numbers in italic are the P values, indicating the significances of the associated variable coefficients. The above tables also report the adjusted R-square for the regression of cross sectional data for each year and the number of observations (Obs). Pooled Data denotes the coefficients of running the regression on pooled sample. FM Average denotes the average of annual coefficients.
Appendix 3 Coefficients from Annual Regressions of Model with OI for the Years 1990 to 2006

Model: MV = a₀ + a₁E + a₂RD + a₃D + a₄CC + a₅CE + a₆OI

Panel A - Closing Book Value (BV) as a deflator

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**Note:** The above tables show the regression results of the coefficients for the cross sectional data from year 1990 to year 2006. Numbers in italic are the P values, indicating the significances of the associated variable coefficients. The above tables also report the adjusted $R^2$ for the regression of cross sectional data for each year and the number of observations (Obs). Pooled Data denotes the coefficients of running the regression on pooled sample. FM Average denotes the average of annual coefficients.
CHAPTER 5

EVALUATION OF CROSS-SECTIONAL VALUATION MODELS USING OUT-OF-SAMPLE VALUATION ERRORS

5.1 Introduction

Value relevance studies focus on how well particular accounting variables reflect information used by investors. They usually employ valuation models to structure their tests, and to make inferences concerning the coefficients of the accounting amounts in the estimation equation. For example, some studies test whether the coefficient on the accounting amount being studied is significantly different from zero with the predicted sign. Rejecting the null hypothesis of no relationship is interpreted as evidence that the accounting amount is relevant and not totally unreliable. Other studies test whether the estimated coefficient on the accounting amount being studied is different from those on other specified amounts recognized in financial statements. Rejecting the null that the coefficients are the same is interpreted as evidence that the accounting amount being studied has relevance and reliability that differs from the specified amounts.

To investigate the value relevance of an accounting variable of their particular research interest, value relevance research usually chooses a base valuation model to build on. A widely employed benchmark valuation model is based on Ohlson (1995), where market value is modelled as a linear function of book value and earnings. Evidence from empirical accounting research in the UK, however, suggest that variables other than book

The first research question raised in our study then is if these accounting variables found to be empirically associated with market value should be included in the base model to form a better specified benchmark model for value relevance studies. In particular, building on Rees (1997) and Akbar and Stark (2003a), we use an extended firm valuation model where corporate value is modelled as a linear function of book value, earnings, research and development expenditures, dividends, capital contributions and capital expenditures. We compare this extended model against the benchmark model often used in value relevance studies mentioned above. We also include a variable to capture ‘other information’, using the approach of Akbar and Stark (2003a) which minimises data loss in the estimation of this variable, to investigate the impact of “other information” on model specifications.

To avoid inappropriate inferences drawn from the estimation results, most value relevance research employs well-established techniques to mitigate the effects of various econometric issues that arise in these studies. Econometric problems include coefficient
bias induced by correlated omitted variables, errors-in-variables, cross-sectional differences in valuation parameters, and inefficient coefficient standard errors induced by heteroscedasticity. Most accounting research deflates the valuation model by some measure of “size”, or uses White (1980) consistent standard error and covariance estimates when obtaining t-statistics, or both, to reduce the effects caused by these econometric problems, without going into much detail about the essence of these issues and the effects of the measures adopted.

Further, a group of recent studies consider a general econometric problem that can arise in the context of value relevance studies. This problem is that inappropriate inferences can be drawn from samples of firms exhibiting substantial size-related variation. This problem is sometimes referred to in these studies as the ‘scale effect’. These studies offer conflicting recommendations for mitigating scale effects, and the differing treatments of scale problems reflect the fact that there is not a single well-defined concept, or problem, of scale in accounting research. Nonetheless, concerns with ‘scale effects’ represent a broad distrust that reflects a variety of potential econometric effects mentioned in the previous paragraph, and deflation is still regarded as one of the effective measures to mitigate general econometric problems associated with “scale”. The discussion of the most effective deflator, however, remains unresolved.

In this part of the research, we compare the performance of various different deflators, all of which can be viewed as proxies for scale and are used in prior value relevance studies.

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when estimating firm valuation models. We intend to identify, if possible, which deflator produces the best specified valuation models.

Along with the choosing of a suitable deflator has been chosen, a further estimation issue arises in value relevance studies based upon firm (undeflated) valuation model equations. One line of logic (mainly based upon the idea that the ‘scale effect’ is heteroscedasticity) is that the equation should be divided through by the deflator. As a consequence, the deflated valuation model only contains a constant term if the deflator is a variable in the undeflated equation. Furthermore, the inverse of the deflator is also a variable in the estimated equation.

Many studies in the valuation relevance literature, however, do not adopt this approach. Instead, they deflate the dependent and independent variables by a chosen deflator and substitute the deflated variables for the undeflated variables in the valuation model and proceed as if this approach is equivalent to estimating the undeflated model. In effect, however, this practice is equivalent to including the deflator as a variable in the undeflated valuation equation. As Akbar and Stark (2003b) point out, comparing deflators under this approach cannot be separated from comparing competing valuation models. As a consequence of the above, we also compare the performance of deflated models which include constant terms with the performance of those that do not.

We include a constant term in the valuation model equations to capture the mean effect of omitted variables.
Last but not least, following prior research (Choi, O’Hanlon and Pope, 2006) which suggests that the impact of accounting conservatism is likely to differ between high-intangible and low-intangible sectors, we estimate valuation models separately on high-intangible firms and low intangible firms, to see if such a procedure provides superior performance, in conjunction with various model specifications investigated.

As discussed so far, our study intends to investigate various model specification issues associated with value relevance studies. We suggest using an alternative metric for evaluating the appropriateness of various model specifications and estimation approaches within the context of value relevance studies. Our approach is to use out-of-sample proportional valuation errors.

This underlying metric has been used before in evaluating the performance of valuation models. In particular, following Dechow, Hutton and Sloan (1999) and Choi, O’Hanlon and Pope (2006) evaluate the Ohlson valuation model (1995) and a conservatism-adjusted Ohlson valuation model respectively using US data and proportional valuation errors (i.e., the difference between the estimated market value and the actual firm value divided by the actual firm value) as the underlying metric. The logic is straightforward. A superior valuation model should be less biased (smaller average proportional valuation error) and more accurate (smaller mean absolute and mean squared valuation errors) in its value estimates than an inferior valuation model. By extension, and intuitively, the individual coefficient estimates embedded within a superior valuation model can be argued to be more reliable than those embedded within an inferior valuation model and,
as a consequence, inferences drawn from the former are more reliable than those drawn from the latter.

Our application of the proportional valuation error metric, however, is different from that of Choi, O’Hanlon and Pope (2006). Whereas they compare two different underlying valuation models, we compare different model specifications to estimating the valuation models within the context of value relevance studies, including the performance of two valuation models with and without the incorporation of “other information”, the effectiveness of deflating with various proxies for scale, estimating the deflated model with and without a constant term, and the influence of estimating the models on high- and low-intangible firms separately.

As might be expected, the results suggest that the extended valuation model, which includes many of the accounting variables found to be associated with market value in the UK, performs better than the simple benchmark model widely adopted in prior US research, where market value is regressed on book value and earnings. The evidence is not strong on whether the inclusion of ‘other information’ improves the performance of the models. Neither is there any clear evidence that one particular deflator out of the five we investigate outperforms the others, although book value, opening market value and closing book value perhaps perform better than sales and number of shares. We also find that deflating the full equation, including the constant term of the undeflated model, and hence estimating without a constant term in the deflated model, provides less bias and more accurate value estimates. Also, estimating on high- and low intangible firms
separately, instead of pooling the full sample for estimation, provides better performance in all cases, which is consistent with the findings of Choi, O’Hanlon and Pope (2006).

5.2 Results analysis

As discussed in details above in section 3.3.4.3.3, the effects of using different estimation equations are investigated via estimating the following equations:

\[
\frac{MV_i}{S_i} = \frac{1}{S_i} + \sum \alpha_i \frac{AV_{it}}{S_i} + \varepsilon
\]  
(5.1)

\[
\frac{MV_i}{S_i} = \frac{1}{S_i} + \sum \alpha_i \frac{AV_{it}}{S_i} + \beta \frac{OI_{it}}{S_i} + \varepsilon
\]  
(5.2)

\[
\frac{MV_i}{S_i} = \gamma + \frac{1}{S_i} + \sum \alpha_i \frac{AV_{it}}{S_i} + \varepsilon
\]  
(5.3)

\[
\frac{MV_i}{S_i} = \gamma + \frac{1}{S_i} + \sum \alpha_i \frac{AV_{it}}{S_i} + \beta \frac{OI_{it}}{S_i} + \varepsilon
\]  
(5.4)

Equations (5.1) to (5.4) allow us to make a number of comparisons.\(^39\) We can compare regressing without and with constant term \(\gamma\) by comparing the results for equations (5.1) and (5.3), or (5.2) and (5.4). We can compare the results with and without ‘other information’, using equations (5.1) and (5.2), or (5.3) and (5.4). We can also compare the results between using a simple valuation model, when \(i = 1, 2\) and the model is specified as including \(BV\) and \(E\) alone as the accounting variables, with the case when \(i = 1, \ldots, 6\) and we include \(BV, E, RD, D, CC, CE\) as the accounting variables.

\(^39\) With deflated models, we proxy \(\beta OI_{it-1}\) by \(St_{t-1}\). Hence, for year \(t\), we use \(St_{t-1}\) as a proxy of \(OI_{it}\), and \(st_{t-1}\) can be obtained by running the appropriate deflated regression with all available data up to year \(t-1\), with \(st_{t-1}\) the firm-specific error term.
Finally, to compare the effect of different ‘scale’ proxies, $S$, we use five different deflators, as discussed in the previous chapter of literature review - closing book value ($BV$), sales ($SALES$), number of shares ($NoSHARES$), opening market value ($OMV$) and closing market value ($MV$).

As we compare different model specifications to estimating the valuation models within the context of value relevance studies, including the performance of estimating the deflated model with and without a constant term, two valuation models with and without the incorporation of “other information”, the effectiveness of deflating by various proxies for scale, and the influence of estimating the models on high- and low-intangible firms separately, all these provide 80 possible combinations (metrics of valuation errors). In order to present the results in a simplified fashion, but in a way which we believe is a representative presentation of our major findings, we use the following sequence: (i) estimating the deflated model with and without a constant term (5.2.1); (ii) estimating high- and low-intangible firms separately versus full sample (5.2.2); (iii) comparing benchmark model with the extended model (5.2.3); and (iv) the effect of “other information” (5.2.4). Discussion of the performance of various deflators is included throughout these sections.

5.2.1 Comparing remedies – estimating the deflated model with and without a constant term

As discussed above in the research methodology section, deflating by some measure of ‘size’ is often suggested and used in value relevance studies as a remedy for solving the
problem of heteroscedasticity, which can suggest estimating the model without a constant term in the deflated model. In contrast, if there is a correlated omitted variable related to scale in the undeflated model, empirically a constant term can be added to the deflated estimation regression. Table 5.1 presents two sets of valuation errors statistics relating to the two types of estimation specification, one regressing without a constant term in the deflated model (equations (5.1) and (5.2)) and one with a constant term (equation (5.3) and (5.4)). The first set of rows presents the out-of-sample mean valuation error ($MVE$), mean absolute error ($MAE$) and mean squared error ($MSE$) obtained from regressing without a constant term in the deflated model using the simple benchmark model where market value is expressed as a linear combination of book value and earnings. The second set of rows arise from regressing with a constant term in the deflated model using the extended model where market value is expressed as a linear combination of book value, earnings, research and development expenses, dividends, capital contributions and capital expenditure.

Before comparing the alternative estimation specifications, note that, for the second set of columns, if the deflator used is already either a dependent or the independent variable of the undeflated model, then we get the same results for both specifications, or we cannot estimate with a constant term in the deflated model. Taking the simple benchmark model as an example, if we use $BV$ as a proxy for scale:

$$MV = \alpha_0 + \alpha_1 BV + \alpha_2 E + BV \varepsilon$$  \hspace{1cm} (5.5)

Deflating the equation above by $BV$, then it can be restated as:
If we replace \( S \) with \( BV \) in equation (5.6), we get:

\[
\frac{MV}{BV} = \alpha_1 + \alpha_0 \frac{1}{BV} + \alpha_2 \frac{E}{BV} + \epsilon
\]  

(5.6)

and deflating equation (5.7) by \( BV \), we get:

\[
MV = \alpha_0 + (\alpha_1 + \gamma)BV + \alpha_2 E + BV \epsilon
\]  

(5.7)

Hence, for both remedies, one regressing without a constant term in the deflated model (equations (5.1) and (5.2)) and one with a constant term (equation (5.3) and (5.4)), the equations for estimation are empirically identical when book value is used as a deflator.

If we use \( MV \) as a proxy for ‘scale’, it makes no sense to assume that \( MV \) is included in the equation as an independent variable when it is already the dependent variable.
Table 5.1
Comparing Two Remedies: Valuation Bias and Accuracy for Estimates Without and With a Constant Term in Deflated Model With All Firms

<table>
<thead>
<tr>
<th>Deflator(s)</th>
<th>N</th>
<th>Equation (5.1) – Benchmark Model</th>
<th>Equation (5.3) – Benchmark Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>MVE</td>
<td>MAE</td>
</tr>
<tr>
<td>BV</td>
<td>16825</td>
<td>0.97**</td>
<td>1.29</td>
</tr>
<tr>
<td>SALES</td>
<td>16825</td>
<td>0.25**</td>
<td>1.08</td>
</tr>
<tr>
<td>NoSHARES</td>
<td>16825</td>
<td>-0.57**</td>
<td>0.76</td>
</tr>
<tr>
<td>MV</td>
<td>16825</td>
<td>-0.75**</td>
<td>0.81</td>
</tr>
<tr>
<td>OMV</td>
<td>16825</td>
<td>-0.62**</td>
<td>0.79</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Deflator(s)</th>
<th>N</th>
<th>Equation (5.2) – Extended Model</th>
<th>Equation (5.4) – Extended Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>MVE</td>
<td>MAE</td>
</tr>
<tr>
<td>BV</td>
<td>16352</td>
<td>0.54**</td>
<td>0.88</td>
</tr>
<tr>
<td>SALES</td>
<td>16352</td>
<td>0.49**</td>
<td>1.05</td>
</tr>
<tr>
<td>NoSHARES</td>
<td>16352</td>
<td>-0.46**</td>
<td>0.70</td>
</tr>
<tr>
<td>MV</td>
<td>16352</td>
<td>-0.69**</td>
<td>0.76</td>
</tr>
<tr>
<td>OMV</td>
<td>16352</td>
<td>-0.52**</td>
<td>0.73</td>
</tr>
</tbody>
</table>

Note: The two remedies we compare are estimating deflated models without a constant term – equation (5.1) and (5.2) and estimating deflated models with a constant term – equation (5.3) and (5.4), as below:

Equation (5.1) – Benchmark Model: $MV/S = \alpha_0 + \alpha_1B/V/S + \alpha_2E/S + \epsilon$
Equation (5.2) – Extended Model: $MV/S = \alpha_0 + \alpha_1B/V/S + \alpha_2E/S + \alpha_3RD/S + \alpha_4D/S + \alpha_5CC/S + \alpha_6CE/S + \epsilon$
Equation (5.3) – Benchmark Model: $MV/S = \gamma + \alpha_0B/V/S + \alpha_2E/S + \epsilon$
Equation (5.4) – Extended Model: $MV/S = \gamma + \alpha_0B/V/S + \alpha_1B/V/S + \alpha_2E/S + \alpha_3RD/S + \alpha_4D/S + \alpha_5CC/S + \alpha_6CE/S + \epsilon$

$MV$ is market value of equity six month after financial year end date, $B/V$ is book value of equity, $E$ is earnings, $RD$ is research and development expenditure, $D$ is dividends, $CC$ is negative capital contribution, $CE$ is capital expenditure, $SALES$ is net sales, $NoSHARES$ is common shares outstanding, $OMV$ is opening market value of equity six month before the financial year end date.

$MVE$ is mean valuation error, $MAE$ is mean absolute error, and $MSE$ is mean squared error.

$n$ is the number of firms when pooling the whole sample.

** indicates whether $MVE$ is significantly different from zero at .01 significance level, based on the t-statistic.
The first set of columns of table 5.1 show the valuation errors from estimating the benchmark or the extended model without a constant term. The second set of columns presents those from estimating these two models with a constant term. Comparing the alternative estimation specifications (i.e., comparing the two sets of columns of table 5.1) reveals that both specifications are biased (i.e., we reject the null hypothesis that MVE is significantly different from zero), using all deflators. Nonetheless, estimating without a constant term generally provides less bias (i.e., MVE is closer to zero), than estimating with a constant term. With respect to accuracy, estimating without a constant term provides more accurate market value estimates if MSE is the metric. The same is true if MAE is the metric other than when using OMV as the deflator.

In summary, deflating the whole equation with the scale factor and, hence, estimating, where necessary, without a constant term in the deflated model seems to generally provide a less biased and more accurate estimation specification, for levels specifications. Nonetheless, when deflating by OMV, including a constant term provides improvements in bias and accuracy, if accuracy is measured using MAE. If accuracy is measured by MSE, however, adding in a constant term results in more inaccurate market value estimates.

\[40\] These results are robust to the inclusion of OI in both the benchmark and extended model.
5.2.2 Separating firms into high and low-intangible asset subsamples for estimation

Based on the conclusion above, we now investigate if separating the sample into high and low-intangible sub-samples for estimation can generate better specifications, reporting only results obtained from estimating deflated equations without a constant term.\textsuperscript{41} Table 5.2 presents the mean, mean absolute, and mean square, proportional valuation errors for estimating the valuation models with either the full sample or using sub-samples separated using the market-to-book ratio.

\textsuperscript{41} Loss-making firms are suggested to have different characteristics for valuation. We identify loss-making firms as a sub-sample and, further, split the profit-making firms into high- and low-intangible asset firms. However, splitting the full sample into three dimensions for estimation does not lower the estimation bias or improve accuracy.
Table 5.2

Valuation Bias and Accuracy When Estimating on the Full Sample vs. Estimating on High- and Low-intangible Asset Firms Separately

*Benchmark model: MV/S = α₀1/S + α₁BV/S + α₂E/S + ε*

<table>
<thead>
<tr>
<th>Deflator(s)</th>
<th>n</th>
<th>MVE</th>
<th>MAE</th>
<th>MSE</th>
<th>MVE</th>
<th>MAE</th>
<th>MSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>BV</td>
<td>16825</td>
<td>0.96**</td>
<td>1.29</td>
<td>11.08</td>
<td>0.35**</td>
<td>0.69</td>
<td>3.94</td>
</tr>
<tr>
<td>SALES</td>
<td>16825</td>
<td>0.24**</td>
<td>1.07</td>
<td>7.27</td>
<td>0.17**</td>
<td>0.71</td>
<td>2.92</td>
</tr>
<tr>
<td>NoSHARES</td>
<td>16825</td>
<td>-0.57**</td>
<td>0.76</td>
<td>0.93</td>
<td>-0.43**</td>
<td>0.64</td>
<td>0.70</td>
</tr>
<tr>
<td>MV</td>
<td>16825</td>
<td>-0.75**</td>
<td>0.81</td>
<td>0.73</td>
<td>-0.61**</td>
<td>0.68</td>
<td>0.57</td>
</tr>
<tr>
<td>OMV</td>
<td>16825</td>
<td>-0.62**</td>
<td>0.79</td>
<td>0.80</td>
<td>-0.49**</td>
<td>0.66</td>
<td>0.60</td>
</tr>
</tbody>
</table>

*Extended model: MV/S = α₀1/S + α₁BV/S + α₂E/S + α₃RD/S + α₄D/S + α₅CC/S + α₆CE/S + ε*

<table>
<thead>
<tr>
<th>Deflator(s)</th>
<th>n</th>
<th>MVE</th>
<th>MAE</th>
<th>MSE</th>
<th>MVE</th>
<th>MAE</th>
<th>MSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>BV</td>
<td>16352</td>
<td>0.54**</td>
<td>0.88</td>
<td>5.50</td>
<td>0.24**</td>
<td>0.58</td>
<td>2.55</td>
</tr>
<tr>
<td>SALES</td>
<td>16352</td>
<td>0.49**</td>
<td>1.05</td>
<td>8.13</td>
<td>0.14**</td>
<td>0.63</td>
<td>2.46</td>
</tr>
<tr>
<td>NoSHARES</td>
<td>16352</td>
<td>-0.46**</td>
<td>0.70</td>
<td>0.82</td>
<td>-0.37**</td>
<td>0.59</td>
<td>0.56</td>
</tr>
<tr>
<td>MV</td>
<td>16352</td>
<td>-0.69**</td>
<td>0.76</td>
<td>0.67</td>
<td>-0.57**</td>
<td>0.64</td>
<td>0.52</td>
</tr>
<tr>
<td>OMV</td>
<td>16352</td>
<td>-0.52**</td>
<td>0.73</td>
<td>0.82</td>
<td>-0.42**</td>
<td>0.62</td>
<td>0.59</td>
</tr>
</tbody>
</table>

Note: *MV* is market value of equity six months after financial year end date, *BV* is book value of equity, *E* is earnings, *RD* is research and development expenditure, *D* is dividends, *CC* is negative capital contribution, *CE* is capital expenditure, *SALES* is net sales, *NoSHARES* is common shares outstanding, *OMV* is opening market value of equity six months before the financial year end date. *MVE* is mean valuation error, *MAE* is mean absolute error, and *MSE* is mean squared error. *n* is the number of firms when pooling the whole sample. ** indicates whether *MVE* is significantly different from zero at .01 significance level, based on the t-statistic.
Comparing the two sets of column in table 5.2, we get results consistent with those in Choi, O’Hanlon and Pope (2006). Estimating valuation models on high- and low-intangible asset firms separately provides lower levels of bias and increases the accuracy of value estimates across all deflators relevant to pooling all firms for estimation.\footnote{42} This is especially the case for the extended model.

5.2.3 The benchmark versus the extended model

We now compare the performances of the benchmark and the extended valuation models, estimated without a constant term. Comparison between the top and bottom parts of Table 5.2 above reveals that the extended model provides less bias and a more accurate valuation model comparing to the simple benchmark model widely used by prior studies.\footnote{43} The only exceptions are for $MVE$ and $MSE$ when Sales is the deflator.

We believe that this generally indicates that the benchmark model, where market value is regressed on book value and earnings alone, does not provide a reliable model for building on in value relevance studies. By implication, including other value-relevant accounting items as additional independent variables in the valuation model will generally provide a better valuation model upon which to build.

\footnote{42}{The finding still holds if we include $OI$ in both the simple and extended models.}
\footnote{43}{The findings are largely robust when we consider the full sample.}
5.2.4 The effect of ‘other information’

It is expected that the inclusion of ‘other information’ in the model will improve the performance of the estimation specifications. We now compare the performance of the valuation models with and without ‘other information’. Based upon the results above, we do so only for only the extended model. Further, we estimate the models separately on low- and high-intangible asset firms, and without a constant term in the deflated equation. Table 5.3 provides the results.

Table 5.3

Valuation Bias and Accuracy of Extended Model With and Without OI (Estimating High- and Low-intangible Asset Firms Separately)

\[ MV/S = \alpha_0 + \alpha_1 B/S + \alpha_2 E/S + \alpha_3 RD/S + \alpha_4 D/S + \alpha_5 C/S + \alpha_6 CE/S + (\alpha_0 OI/S) + \epsilon \]

<table>
<thead>
<tr>
<th>Deflator(s)</th>
<th>Extended Model without OI</th>
<th>Extended Model with OI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>MVE</td>
</tr>
<tr>
<td>BV</td>
<td>16352</td>
<td>0.24**</td>
</tr>
<tr>
<td>SALES</td>
<td>16352</td>
<td>0.14**</td>
</tr>
<tr>
<td>NoSHARES</td>
<td>16352</td>
<td>-0.37**</td>
</tr>
<tr>
<td>MV</td>
<td>16352</td>
<td>-0.57**</td>
</tr>
<tr>
<td>OMV</td>
<td>16352</td>
<td>-0.42**</td>
</tr>
</tbody>
</table>

Note: MV is market value of equity six month after financial year end date, BV is book value of equity, E is earnings, RD is research and development expenditure, D is dividends, CC is negative capital contribution, CE is capital expenditure, SALES is net sales, NoSHARES is common shares outstanding, OMV is opening market value of equity six month before the financial year end date. OI is other information.\(^{44}\) MVE is mean valuation error, MAE is mean absolute error, and MSE is mean squared error. \(n\) is the number of firms when pooling the whole sample.

** indicates whether MVE is significantly different from zero at .01 significance level, based on the t-statistic.

\(^{44}\) Details of estimation of “other information” are covered in section 2.2.3.8.
The comparison between the two columns of table 5.3 indicates that including \(OI\) reduces bias for all deflators. Estimating with \(OI\) generally results in (slightly) more accurate value estimates for \(BV\), \(SALES\) and \(MV\) as deflators. For \(NoShares\) as deflator, the inclusion of ‘other information’ produces less accurate valuations using both measures of accuracy. For \(OMV\), the evidence on accuracy is mixed with respect to the accuracy metrics. One explanation may be that, as \(OI\) is measured with last period’s accounting items within the model, as explained in the section above, it could be correlated with the other independent variables, which may influence the performance of this particular estimation specification.

To summarize our findings, we would argue that a valuation model specification that is estimated without a constant term in the deflated model, estimates the model on high- and low-intangible asset firms separately, and uses the extended model, probably with \(OI\), provides the best specified model, as measured by valuation bias and accuracy. Using this model specification, we now investigate if any particular deflator is ‘best’ in producing the least valuation bias and highest valuation accuracy.

If a specification with \(OI\) is considered on the right-side column of table 5.3, deflation by sales results in the smallest bias (\(MVE\)), with book value deflation and opening market value deflation the next least biased. However, according to valuation accuracy measures (\(MAE\) and \(MSE\)), all deflators seem to perform more or less the same, with market value deflation seem to provide more accurate value estimates, with number of shares deflation slightly less accurate. Combining the two criteria, it is difficult to identify the “best”
deflator, although book value and opening and closing market value appear to generally perform better than sales and number of shares.

5.3 Summary

This study uses out-of-sample valuation errors as an alternative metric for capturing the effectiveness of various estimation approaches in generating reliable estimates of coefficients in accounting-based valuation models, and accordingly, less valuation bias and higher valuation accuracy. Valuation bias is expressed as mean proportional valuation errors, where estimated market value less the actually observed market value divided by the actual market value is the proportional valuation error, and valuation accuracy is measured by both mean absolute and mean squared proportional valuation error.\(^{45}\)

We find that deflating the full equation, including the constant term of the undeflated model and, hence, estimating without a constant term in the deflated model, provides less bias and more accurate value estimates.\(^{46}\) Also, estimating models on high- and low intangible firms separately, instead of pooling the full sample for estimation, provides better performance in all cases, which is consistent with the findings of Choi, O’Hanlon and Pope (2006). As expected, the results suggest that an extended model including the main accounting variables found to be associated with market value in the UK proves a

\(^{45}\) It is recognized that a good model should both forecast well and produce plausible coefficient values. Discussion of the economic plausibility of the coefficients is in Chapter 4, section 4.5.2.

\(^{46}\) Empirically deflating with BV and MV results in identical deflated equations, and more details are covered in section 5.2.1.
better specification than a benchmark model widely adopted in prior research, where market value is regressed on book value and earnings alone. The evidence also shows that the inclusion of ‘other information’ largely seems to improve the performance with respect to valuation errors. However, there is no clear evidence that one particular deflator out of the five we investigate outperforms the others, although book value and opening and closing market value appear to generally perform better than sales and number of shares.
CHAPTER 6

EVALUATION OF CROSS-SECTIONAL VALUATION MODELS USING PORTFOLIO ANALYSIS

6.1 Introduction

Kothari (2001, p79) comments on the criterion to evaluate valuation models, he suggests that “assuming efficient markets, one objective of a valuation model is to explain observed share prices. Alternatively, in an inefficient capital market, a good model of intrinsic or fundamental value should predictably generate positive or negative abnormal returns. Therefore, in the spirit of positive science, it is worthwhile examining which of these models best explains share prices and/or which has the most predictive power with respect to future returns.”

This chapter investigates if accounting-based valuation models, where market value is regressed on accounting variables found to be value relevant in previous studies in the UK, can be used to develop profitable portfolio strategies. The models are estimated using book value as the deflator. The models are estimated annually. Following Dechow, Hutton and Sloan (1999), who provide an empirical test of Ohlson’s residual income valuation model using US data, and Gregory, Saleh and Tucker (2005), who conduct a UK test of a modified version of Ohlson model with inflation adjustments using the approach of portfolio analysis, we form decile portfolios using the difference between predicted model value and observed equity value divided by the latter.
Essentially, if profitable strategies can be developed, this suggests that the accounting-based valuation models generate superior estimates of firms’ intrinsic value than market values. Alternatively, if such strategies cannot be developed, this suggests the stock market is informationally efficient with respect to the information contained in the accounting-based models estimated and, as a consequence, it seems reasonable to use such models as a basis for value relevance studies.

The underlying rationale behind the tests is straightforward. We assume the predicted model value can be treated as a proxy of the intrinsic equity value. Lower deciles consist of stocks that are relatively overpriced with respect to intrinsic value and are, therefore, expected to experience lower future abnormal stock returns. Higher deciles consist of stocks that are relatively underpriced with respect to intrinsic value, and are therefore expected to experience higher future abnormal stock returns.

Instead of testing Ohlson’s residual income valuation models, which requires the prediction of systems of linear information dynamics, our empirical tests focus on a firm valuation model that is developed within the UK context, where market value is expressed as a linear combination of accounting variables that have been found to associated with market value in prior UK studies, such as book value, earnings, dividends, research and development expenditures, capital contributions, capital expenditures and other information. Our study uses a broad set of risk controls to calculate abnormal returns generated from the portfolio strategy.
We consider the profitability of buy-and-hold portfolio strategies, and our results show firms in the higher deciles seem to generate higher abnormal returns than those in the lower deciles. None of the (initially) equally- and value-weighted strategies, however, are profitable. Therefore, we conclude that there is no “mispricing” effect associated with accounting-based valuation models developed within the UK context.

We present and analyze the results in this chapter. First, we briefly discuss the process of using pricing errors to form decile portfolios, and also how portfolio abnormal returns are calculated to evaluation the investment strategies. Second, we discuss in detail the characteristics of decile portfolios and demonstrate how the decile portfolios are associated with common risk factors. Characteristics of the benchmark portfolios are also discussed. Lastly, we present the risk-adjusted portfolio abnormal returns to test for the existence of “mispricing” effect in the UK. The chapter then concludes.

6.2 Forming decile portfolios and evaluating portfolio performances

The procedure for estimating the in-sample valuation errors for ranking follows closely that used by Dechow Hutton and Sloan (1999), details of which are covered in section 3.4.2. All sample firms are ranked by their error ratios generated from the valuation model where market value is regressed on book value, earnings, dividends, research and development expenditures, capital contributions, capital expenditures and “other

47 As discussed in the chapter of research methodology, five different deflators (closing book value, sales, number of shares, opening market value and closing market value) are used for analysis, however all results presented in this chapter are mainly results when closing book value is used. Main findings are largely consistent when different deflators are used, and this will be discussed further within this chapter.
information”. For firms with a positive error ratio, its estimated market value is higher than the observed market value and, hence, these firms are undervalued by the market according to the valuation model and are predicted to have positive abnormal returns. In contrast for firms with a negative error ratio, we expect negative abnormal returns.

As a result, we assume the decile portfolios are formed at the beginning of July of Year $t$, and we estimate buy and hold returns for the decile portfolios. Further, we estimate the results of buying firms in the highest decile (firms with the highest error ratios, expected to have higher future abnormal returns) for 12 months, whilst selling short the lowest decile (firms with the lowest error ratios, expected to have lower future abnormal returns). These investment strategies are repeated every year.

To evaluate the performance of this investment strategy, we need to measure the abnormal returns against a particular benchmark.\textsuperscript{48} Portfolio-matching methods are used in this research to calculate the risk-adjusted portfolio returns. This approach is to match each firm within the portfolio with a benchmark portfolio and the monthly abnormal return for this firm is the firm raw return less the matched benchmark portfolio return. The monthly portfolio abnormal return is then the weighted average of the monthly abnormal returns of each firm within the portfolio. To determine the weight on each firm’s monthly return, we follow the method suggested by Liu and Strong (2009) to decompose the monthly buy-and-hold portfolio returns, where the wealth values are the bases for forming portfolio weights.\textsuperscript{49}

\textsuperscript{48} Details of portfolio performance assessment are covered in section 3.4.

\textsuperscript{49} Explanation of how the weight is calculated can be found in section 3.4.3.
6.3 Characteristics of decile portfolios

Table 6.1 reports a set of characteristics for the decile portfolios created by pricing errors that are calculated as the difference between estimated market value and actual market value scaled by the actual market value. Therefore, lower deciles consist of firms with lower/negative pricing errors (i.e., are relatively overpriced by the market according to the intrinsic value predicted by the accounting-based valuation model) and are expected to experience lower future abnormal stock returns. Higher deciles consist of stocks that are relatively underpriced with respect to intrinsic value and are, therefore, expected to experience higher future abnormal stock returns.

Judging by the averages for each portfolio, firms in highest deciles are the smallest in size, have the highest book-to-market (BV_MV) ratios and lowest levels of income (E_BV), are the most RD intensive (RD_MV), have the highest dividend yields (D_MV), the highest levels of capital contributions (CC_MV) and capital expenditures (CE_MV), and also are firms with low EP ratios. Comparisons between means and medians suggest that the data for the various characteristics is skewed, although many of the observations in the previous sentence still hold when using medians as the measure of central tendency.

A closer inspection of the characteristics across deciles suggests that the a number of the relationships between decile number and characteristics are not monotonic. For example, size and EP generally declines from decile two to decile ten, but the mean and median sizes for decile one is notably smaller than for decile two. Similarly, the book-to-
market ratio and capital expenditures increases from decile two to decile ten, but the ratios for decile one are much higher than that for decile two.

Some of these characteristics, such as size and book-to-market ($BV_{MV}$), are widely acknowledged as risk factors associated with returns. The patterns indicate that the portfolios generated from pricing errors are associated with common risk factors. For example, the highest decile portfolio, in particular, consists of the smallest firms (both by mean and median size measure) with the highest book-to-market ratios, and, hence, should enjoy higher returns. The largest firms with the lowest book-to-market ratios, however, seem to cluster in the second lowest portfolio, instead of the lowest one. If the accounting-based valuation models are assumed to capture intrinsic value, the firms predicted as being underpriced are firms that are the smallest in size with the highest book-to-market ratio, and with the highest level of research and development expenses, and hence, very risky, and are expected to generate higher future abnormal returns.
Table 6.1 Mean (Median) Values of the Characteristics of Decile Portfolios

<table>
<thead>
<tr>
<th></th>
<th>Lowest</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>Highest</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRICING ERROR</td>
<td>-1.410</td>
<td>-0.350</td>
<td>-0.166</td>
<td>-0.017</td>
<td>0.134</td>
<td>0.304</td>
<td>0.512</td>
<td>0.796</td>
<td>1.261</td>
<td>3.851</td>
</tr>
<tr>
<td></td>
<td>(-0.657)</td>
<td>(-0.327)</td>
<td>(-0.161)</td>
<td>(-0.023)</td>
<td>(0.118)</td>
<td>(0.280)</td>
<td>(0.485)</td>
<td>(0.761)</td>
<td>(1.182)</td>
<td>(2.454)</td>
</tr>
<tr>
<td>SIZE</td>
<td>399105.74</td>
<td>1161928.43</td>
<td>1068177.27</td>
<td>1102209.29</td>
<td>1010398.89</td>
<td>667370.70</td>
<td>539350.57</td>
<td>420466.09</td>
<td>410219.06</td>
<td>94214.27</td>
</tr>
<tr>
<td></td>
<td>(48,945.01)</td>
<td>(112,834.00)</td>
<td>(110,748.35)</td>
<td>(91,648.25)</td>
<td>(91,648.95)</td>
<td>(43,776.17)</td>
<td>(24,434.72)</td>
<td>(15,609.91)</td>
<td>(8,229.36)</td>
<td></td>
</tr>
<tr>
<td>BV_MV</td>
<td>0.632</td>
<td>0.389</td>
<td>0.434</td>
<td>0.491</td>
<td>0.554</td>
<td>0.661</td>
<td>0.771</td>
<td>0.924</td>
<td>1.103</td>
<td>1.776</td>
</tr>
<tr>
<td></td>
<td>(0.319)</td>
<td>(0.261)</td>
<td>(0.331)</td>
<td>(0.396)</td>
<td>(0.462)</td>
<td>(0.558)</td>
<td>(0.673)</td>
<td>(0.816)</td>
<td>(0.958)</td>
<td>(1.270)</td>
</tr>
<tr>
<td>E_BV</td>
<td>13.106</td>
<td>-0.026</td>
<td>-0.013</td>
<td>-1.191</td>
<td>-0.014</td>
<td>0.007</td>
<td>-0.445</td>
<td>-0.157</td>
<td>-0.049</td>
<td>-0.426</td>
</tr>
<tr>
<td></td>
<td>(0.033)</td>
<td>(0.149)</td>
<td>(0.146)</td>
<td>(0.137)</td>
<td>(0.129)</td>
<td>(0.111)</td>
<td>(0.098)</td>
<td>(0.075)</td>
<td>(0.051)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>RD_MV</td>
<td>0.015</td>
<td>0.009</td>
<td>0.010</td>
<td>0.012</td>
<td>0.012</td>
<td>0.013</td>
<td>0.013</td>
<td>0.017</td>
<td>0.022</td>
<td>0.053</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>D_MV</td>
<td>0.015</td>
<td>0.015</td>
<td>0.020</td>
<td>0.023</td>
<td>0.026</td>
<td>0.029</td>
<td>0.031</td>
<td>0.035</td>
<td>0.039</td>
<td>0.063</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.013)</td>
<td>(0.018)</td>
<td>(0.021)</td>
<td>(0.025)</td>
<td>(0.027)</td>
<td>(0.029)</td>
<td>(0.032)</td>
<td>(0.032)</td>
<td>(0.029)</td>
</tr>
<tr>
<td>CC_MV</td>
<td>-0.038</td>
<td>-0.024</td>
<td>-0.026</td>
<td>-0.028</td>
<td>-0.032</td>
<td>-0.032</td>
<td>-0.035</td>
<td>-0.045</td>
<td>-0.052</td>
<td>-0.182</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(-0.001)</td>
<td>(-0.002)</td>
<td>(-0.001)</td>
<td>(-0.002)</td>
<td>(-0.001)</td>
<td>(-0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>CE_MV</td>
<td>0.098</td>
<td>0.050</td>
<td>0.053</td>
<td>0.062</td>
<td>0.066</td>
<td>0.080</td>
<td>0.088</td>
<td>0.111</td>
<td>0.135</td>
<td>0.317</td>
</tr>
<tr>
<td></td>
<td>(0.030)</td>
<td>(0.027)</td>
<td>(0.035)</td>
<td>(0.040)</td>
<td>(0.046)</td>
<td>(0.053)</td>
<td>(0.061)</td>
<td>(0.071)</td>
<td>(0.083)</td>
<td>(0.103)</td>
</tr>
<tr>
<td>EP</td>
<td>-0.675</td>
<td>-0.025</td>
<td>-0.002</td>
<td>0.008</td>
<td>0.017</td>
<td>0.008</td>
<td>0.014</td>
<td>-0.029</td>
<td>-0.044</td>
<td>-0.500</td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
<td>(0.040)</td>
<td>(0.049)</td>
<td>(0.055)</td>
<td>(0.059)</td>
<td>(0.060)</td>
<td>(0.063)</td>
<td>(0.060)</td>
<td>(0.050)</td>
<td>(0.007)</td>
</tr>
</tbody>
</table>

Note: PRICING ERROR is the pricing error, i.e. the difference between estimated market value and actual market value scaled by the actual market value, used to form the decile portfolios; SIZE is measured as the market value at the end of the sixth month after the financial year end; BV_MV is book-to-market ratio; E_BV is earnings-to-book value ratio; RD_MV is research and development expenditures-to-market value ratio; D_MV is dividends-to-market ratio; CC_MV is capital contributions-to-market value ratio; CE_MV is capital expenditures-to-market value ratio and EP is earning-to-market value ratio.
6.4 Monthly returns of benchmark portfolios

To establish the risk-adjusted abnormal returns, we match each share with a benchmark portfolio, and the abnormal return for the share for the period is the actual market return for the share less the matched portfolio return. Sources of benchmarks adopted here are the return on portfolios of firms of similar size (size-matched returns), the return on portfolio of firms with similar book-to-market ratios (book-to-market adjusted returns), or the returns on firms with similar combination of size and book-to-market ratios (size and book-to-market adjusted returns). Size and book-to-market adjusted returns can be calculated using two sorting methods to form the benchmark portfolios, one is sequential sort and the other is intersections. Details of how the benchmark portfolios are formed is covered in section 3.4.4.2. Figure 6.2 below present the average monthly returns of two of the sets of benchmark portfolios – size decile portfolios and book-to-market decile portfolios. Table 6.3 provides the average monthly returns of the other two sets of benchmark portfolios – size and book-to-market decile portfolios (sequential and intersected sorts).
Figure 6.2
Benchmark Portfolio Returns

Note: Figure A shows the average monthly returns of size deciles. Take year 1996 as an example, size decile benchmark portfolios are formed annually on July 1st, 1996 by sorting the sample by the market value of June 30th, 1996. Figure B shows the average monthly returns of book-to-market (BM) deciles. BM decile benchmark portfolios are formed using the ratio of book value reported for the accounting year 1996 over market value at the end of previous year (December 31st, 1995).
Table 6.3

Monthly Benchmark Portfolio Returns (%) – Size and BM Deciles

Panel A: Size and BM deciles benchmark portfolio returns (sequential sort)

<table>
<thead>
<tr>
<th>Size quartile</th>
<th>Book-to-market equity quartile</th>
<th>Initially equally-weighted</th>
<th>Initially value-weighted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Small</td>
<td>0.74</td>
<td>1.10</td>
<td>1.20</td>
</tr>
<tr>
<td>2</td>
<td>0.46</td>
<td>0.93</td>
<td>1.12</td>
</tr>
<tr>
<td>3</td>
<td>1.02</td>
<td>1.26</td>
<td>1.54</td>
</tr>
<tr>
<td>Big</td>
<td>0.76</td>
<td>1.03</td>
<td>1.30</td>
</tr>
</tbody>
</table>

Panel B: Size and BM deciles benchmark portfolio returns (intersected sort)

<table>
<thead>
<tr>
<th>Size quartile</th>
<th>Initially equally-weighted</th>
<th>Initially value-weighted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Small</td>
<td>2</td>
</tr>
<tr>
<td>Small</td>
<td>0.68</td>
<td>0.95</td>
</tr>
<tr>
<td>2</td>
<td>0.46</td>
<td>0.90</td>
</tr>
<tr>
<td>3</td>
<td>1.01</td>
<td>1.25</td>
</tr>
<tr>
<td>Big</td>
<td>0.83</td>
<td>1.20</td>
</tr>
</tbody>
</table>

Note: Size and book-to-market (BM) portfolios are formed via sequential and intersected sorting methods. To illustrate the intersected sorting method, at the end of June for each year \( t \), firms are sorted into four groups, based on their market value by the end of June. Simultaneously, firms are also allocated in an independent sort to four BM groups (BM is calculated as the book value of equity of year \( t \) over the market value at the end of previous year). Sixteen size and book-to-market portfolios are created from the intersections of the four size and four BM groupings. To illustrate the subsequent sorting method, for each year \( t \), firms are sorted into four size groups first. Then, within each size group, stocks are sorted into four BM groups.
The figures above show the characteristics of the benchmark portfolios. Size decile portfolios demonstrate a generally flat pattern of average monthly returns other than for the smallest size portfolio which has substantially higher average returns than the other deciles. This suggests that any size effect over the period studied is concentrated in the smallest firm decile. For book-to-market decile portfolios, benchmark returns generally increase with deciles, which is consistent with the book-to-market effect, where firms with higher book-to-market ratio are firms with more distress risk and generate higher returns, whereas firms with lower book-to-market ratio are less likely to be under financial distress and are associated with lower market returns.

The monthly benchmark returns in table 6.3 suggest that within size deciles, returns of the book-to-market portfolios demonstrate an inverted U-shape pattern, with the exception of the “Big” decile, where for the largest firms, benchmark portfolio returns increase monotonically from the low BM decile to the high BM decile. Within the book-to-market deciles, the benchmark portfolio returns does not demonstrate a clear pattern from the small to big firms, except for the firms with the highest book-to-market ratios, the returns of the benchmark portfolios show a U-shape pattern. Also the alternative sorting methods seem to largely provide the same control for size and book-to-market effects.

6.5 Abnormal portfolio returns

This section investigates whether the implementation of investment strategies based on the pricing errors generated by accounting-based valuation models is able to earn
significant abnormal returns. The analysis is based on the assumption that the valuation model provides a superior estimate of intrinsic value to that provided by market value. In order to investigate this assumption, when the sample is ranked using pricing errors generated from the model, we can test the following null hypotheses below:

$H_1$: Abnormal returns for each decile portfolio are not different from zero.

$H_2$: Firms with lower pricing errors ($P_I$) generate identical abnormal returns to firms with higher pricing errors ($P_{10}$).

Alternatively, the second hypothesis $H_2$ can be expressed as that the hedge returns, the difference between two extreme portfolios, are not significantly different from zero.

The results are presented in Table 6.4, with Panel A reporting the monthly abnormal return of the initially value-weighted investment strategy, and Panel B reporting the results of the initially equally-weighted investment strategy. Although there is some evidence that monthly abnormal returns across deciles generally increase monotonically, especially with size-adjusted abnormal returns, none of these monthly abnormal returns are statistically significant relative to zero and, hence, there is no significant evidence of the “mispricing” effect associated with accounting-based valuation models in the UK. More specifically, the data does not reject hypothesis $H_1$.

Further, the implementation of a hedge strategy based on the accounting-based valuation model produces monthly abnormal returns differences ranging from 0.029% to 0.185%.
(for the initially value-weighted investment approach), and from 0.021% to 0.18% (for the initially equally-weighted investment approach), depending on the risk control approach used. However, we can not reject $H_2$ because none of these abnormal hedge returns are significant based on $p$-value.
Table 6.4
Monthly Abnormal Returns (%)

<table>
<thead>
<tr>
<th>Deciles</th>
<th>Size Control&lt;sup&gt;a&lt;/sup&gt;</th>
<th>BM Control&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Size/BM Control&lt;sup&gt;b&lt;/sup&gt; (Sequential Sort)</th>
<th>Size/BM Control&lt;sup&gt;b&lt;/sup&gt; (Intersection)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest</td>
<td>0.181</td>
<td>0.135</td>
<td>0.170</td>
<td>0.173</td>
</tr>
<tr>
<td></td>
<td>(0.337)</td>
<td>(0.447)</td>
<td>(0.327)</td>
<td>(0.316)</td>
</tr>
<tr>
<td>P2</td>
<td>0.174</td>
<td>0.293</td>
<td>0.260</td>
<td>0.260</td>
</tr>
<tr>
<td></td>
<td>(0.342)</td>
<td>(0.061)</td>
<td>(0.103)</td>
<td>(0.094)</td>
</tr>
<tr>
<td>P3</td>
<td>-0.154</td>
<td>-0.048</td>
<td>-0.064</td>
<td>-0.046</td>
</tr>
<tr>
<td></td>
<td>(0.140)</td>
<td>(0.624)</td>
<td>(0.518)</td>
<td>(0.634)</td>
</tr>
<tr>
<td>P4</td>
<td>0.140</td>
<td>0.126</td>
<td>0.108</td>
<td>0.093</td>
</tr>
<tr>
<td></td>
<td>(0.187)</td>
<td>(0.276)</td>
<td>(0.282)</td>
<td>(0.358)</td>
</tr>
<tr>
<td>P5</td>
<td>0.104</td>
<td>0.076</td>
<td>0.102</td>
<td>0.056</td>
</tr>
<tr>
<td></td>
<td>(0.365)</td>
<td>(0.505)</td>
<td>(0.336)</td>
<td>(0.596)</td>
</tr>
<tr>
<td>P6</td>
<td>0.125</td>
<td>0.015</td>
<td>-0.031</td>
<td>-0.011</td>
</tr>
<tr>
<td></td>
<td>(0.424)</td>
<td>(0.899)</td>
<td>(0.804)</td>
<td>(0.933)</td>
</tr>
<tr>
<td>P7</td>
<td>-0.018</td>
<td>-0.144</td>
<td>-0.172</td>
<td>-0.161</td>
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<tr>
<td></td>
<td>(0.908)</td>
<td>(0.281)</td>
<td>(0.165)</td>
<td>(0.193)</td>
</tr>
<tr>
<td>P8</td>
<td>0.158</td>
<td>0.018</td>
<td>-0.072</td>
<td>-0.066</td>
</tr>
<tr>
<td></td>
<td>(0.314)</td>
<td>(0.889)</td>
<td>(0.599)</td>
<td>(0.618)</td>
</tr>
<tr>
<td>P9</td>
<td>0.048</td>
<td>-0.175</td>
<td>-0.135</td>
<td>-0.162</td>
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<td>(0.751)</td>
<td>(0.253)</td>
<td>(0.366)</td>
<td>(0.290)</td>
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<td>Highest</td>
<td>0.366</td>
<td>0.170</td>
<td>0.199</td>
<td>0.251</td>
</tr>
<tr>
<td></td>
<td>(0.050)</td>
<td>(0.362)</td>
<td>(0.271)</td>
<td>(0.169)</td>
</tr>
<tr>
<td>Highest-Lowest&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.185</td>
<td>0.034</td>
<td>0.029</td>
<td>0.078</td>
</tr>
<tr>
<td></td>
<td>(0.472)</td>
<td>(0.882)</td>
<td>(0.897)</td>
<td>(0.729)</td>
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Table 6.4 (CONT’D)

<table>
<thead>
<tr>
<th>Deciles</th>
<th>Size Control&lt;sup&gt;a&lt;/sup&gt;</th>
<th>BM Control&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Size/BM Control&lt;sup&gt;b&lt;/sup&gt; (Sequential Sort)</th>
<th>Size/BM Control&lt;sup&gt;b&lt;/sup&gt; (Intersection)</th>
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</thead>
<tbody>
<tr>
<td><strong>Panel B: Initially equally-weighted</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lowest</td>
<td>0.312</td>
<td>0.176</td>
<td>0.185</td>
<td>0.186</td>
</tr>
<tr>
<td></td>
<td>(0.126)</td>
<td>(0.262)</td>
<td>(0.227)</td>
<td>(0.221)</td>
</tr>
<tr>
<td>P2</td>
<td>0.289</td>
<td>0.357</td>
<td>0.295</td>
<td>0.297</td>
</tr>
<tr>
<td></td>
<td>(0.192)</td>
<td>(0.021)</td>
<td>(0.056)</td>
<td>(0.050)</td>
</tr>
<tr>
<td>P3</td>
<td>0.006</td>
<td>0.000</td>
<td>0.011</td>
<td>0.011</td>
</tr>
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<td></td>
<td>(0.960)</td>
<td>(0.998)</td>
<td>(0.904)</td>
<td>(0.907)</td>
</tr>
<tr>
<td>P4</td>
<td>0.241</td>
<td>0.155</td>
<td>0.134</td>
<td>0.132</td>
</tr>
<tr>
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<td>(0.172)</td>
<td>(0.169)</td>
<td>(0.171)</td>
</tr>
<tr>
<td>P5</td>
<td>0.086</td>
<td>0.018</td>
<td>0.012</td>
<td>-0.029</td>
</tr>
<tr>
<td></td>
<td>(0.429)</td>
<td>(0.861)</td>
<td>(0.899)</td>
<td>(0.754)</td>
</tr>
<tr>
<td>P6</td>
<td>0.168</td>
<td>0.026</td>
<td>-0.028</td>
<td>-0.040</td>
</tr>
<tr>
<td></td>
<td>(0.146)</td>
<td>(0.818)</td>
<td>(0.802)</td>
<td>(0.722)</td>
</tr>
<tr>
<td>P7</td>
<td>0.139</td>
<td>-0.100</td>
<td>-0.094</td>
<td>-0.096</td>
</tr>
<tr>
<td></td>
<td>(0.300)</td>
<td>(0.428)</td>
<td>(0.418)</td>
<td>(0.408)</td>
</tr>
<tr>
<td>P8</td>
<td>0.372</td>
<td>0.079</td>
<td>0.042</td>
<td>0.041</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.509)</td>
<td>(0.729)</td>
<td>(0.735)</td>
</tr>
<tr>
<td>P9</td>
<td>0.134</td>
<td>-0.151</td>
<td>-0.138</td>
<td>-0.132</td>
</tr>
<tr>
<td></td>
<td>(0.414)</td>
<td>(0.299)</td>
<td>(0.312)</td>
<td>(0.338)</td>
</tr>
<tr>
<td>Highest</td>
<td>0.492</td>
<td>0.197</td>
<td>0.257</td>
<td>0.313</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.234)</td>
<td>(0.095)</td>
<td>(0.045)</td>
</tr>
<tr>
<td>Highest-Lowest&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.180</td>
<td>0.021</td>
<td>0.072</td>
<td>0.127</td>
</tr>
<tr>
<td></td>
<td>(0.481)</td>
<td>(0.925)</td>
<td>(0.731)</td>
<td>(0.543)</td>
</tr>
</tbody>
</table>

<sup>P-values</sup> are presented in parentheses. Monthly returns corrected by the benchmark portfolios returns, where <sup>a</sup> the benchmark is ranked by either Size or BM; <sup>b</sup> the size/BM benchmark portfolios are formed using either sequential sorting method or intersecting size and BM portfolios.

<sup>c</sup> The difference between the two deciles with extreme pricing errors are representing the hedge return obtained by taking a short (long) position in the low (high) pricing error deciles firms. If a company is delisted during the holding period, it is assumed that the proceeds are reinvested in the corresponding benchmark portfolio.
6.6 Robustness Checks

Despite the evidence of statistically insignificant abnormal returns for both initially value-weighted and equally-weighted portfolio strategies, various other possibilities for dividing the sample, as well as different model specifications are also tested as robustness checks.

To test out different specifications of the firm valuation model, we repeat the investment strategy and calculate the abnormal returns using a simple model where market value is regressed on book value and earnings. Moreover, the value-relevant variables are added to the valuation framework one at a time to test out the impact of various model specifications. The evidence again suggests that we cannot make money out of any “mispricing” based upon these models.

Four alternative deflators are used, including sales, number of shares, opening market value and closing market value. There is no significant difference in the conclusions drawn from the analysis in the section above, for instance, when number of shares, a popular choice of deflator, is used. In this case, the initially value-weighted strategy exhibits monthly abnormal returns from a negative 14.8% to a positive 0.274%, but are still statistically insignificant.

Additionally, we also test if the exclusion of loss-making firms from the sample has an impact on the profitability of the investment strategy. We observe that there is no qualitative difference in the conclusions. Firms with research and development
expenditures are also excluded from the sample to test out the impact of RD intensive firms on the conclusions, and there is again no significant difference in the main findings.

Overall, we conclude from the various robustness checks, there is no evidence of “mispricing” effect associated with the firm valuation models in the UK and, hence, the UK market is efficient with respect to the publicly available accounting information specified in the model.

6.7 Summary

This empirical chapter tests for the existence of any “mispricing” effect associated with accounting-based valuation model in the UK. It investigates a specific firm valuation model where market value is expressed as a linear combination of book value, earnings, research and development expenditures, dividends, capital contributions, capital expenditures and other information. All of these accounting variables have been found value relevant in prior studies in the UK. We then rank firms based upon in-sample proportional valuation errors and form decile portfolios from these ranks.

Although firms in the higher deciles tend to have higher abnormal returns than firms in the lower deciles, the difference in abnormal returns between the two extreme portfolios (or the hedge returns) are statistically insignificant. Further, none of the decile portfolio abnormal returns are significant. As a consequence, accounting-based valuation models do not appear to provide superior estimates of intrinsic firm value relative to those provided by market value. We then conclude that the UK market is informationally
efficient with respect to the information contained in the accounting-based valuation models, in the sense that it does not appear to be possible to generate positive abnormal returns based upon publicly available accounting information. As a consequence, the extended valuation model seems to be an adequate base model for use in value relevance studies.
CHAPTER 7

CONCLUDING REMARKS

7.1 Introduction

This chapter concludes the thesis by providing a brief restatement of the research questions responded to above, and a summary of the major findings of this thesis, discussing the limitations of this study, and suggesting potential future research.

7.2 A brief restatement of the research questions of the thesis

As stated in the introductory chapter of the thesis, two specific research questions drive the research in this thesis. The first relates to model specification with respect to the valuation models used in value relevance studies. These issues include: (i) which deflator should be used in estimating empirical accounting-based valuation models; (ii) is it better to use an expanded model rather than one in which the base explanatory variables of market value are earnings and book value; (iii) should there be a constant term in deflated estimation equations if the deflator is not a variable in the model; (iv) should ‘other information’ be included in the empirical model; and (v) should models be separately estimated on low- and high-intangibles companies? The criteria used to evaluate the effectiveness of model specification are the levels of bias and accuracy
demonstrated by out-of-sample proportional valuation errors derived from the various specifications.

The second question relates to whether accounting-based valuation models can provide superior estimates of firms’ intrinsic values relative to those provided by market values. To respond to this question, the expanded models used in responding to the first research question are used, along with market values, to develop simple portfolio strategies, based upon the ranking of firms by in-sample proportional valuation errors. Buy-and-hold portfolio abnormal returns for decile portfolio strategies are computed, using size, book-to-market and size and book-to-market risk controls.

7.3 Summary of the main results

The first empirical study uses out-of-sample valuation errors as an alternative metric to capture the effectiveness of various estimation approaches in generating reliable estimates of coefficients in accounting-based valuation models and, accordingly, less valuation bias and higher valuation accuracy. Valuation bias is expressed as the mean proportional out-of-sample valuation error, where estimated market value less the actually observed market value divided by the actual market value is the proportional valuation error, and valuation accuracy is measured by both the mean absolute and the mean squared proportional valuation error.

We find that deflating the full equation including the constant term of the undeflated model and, hence, estimating without a constant term in the deflated model, provide less
biased and more accurate value estimates relative to when a constant term is included in the deflated regression equation. Also, estimating the valuation model on high- and low-intangible asset firms separately, instead of pooling the full sample for estimation, provides better performance in all cases, which is consistent with the findings of Choi, O’Hanlon and Pope (2006). As expected, the results suggest that an extended model including the main accounting variables found to be associated with market value in the UK is better specified than a benchmark model, widely adopted in prior research, where market value is regressed on book value and earnings alone. Evidences also show that the inclusion of ‘other information’ improves the performance of the models. However, there is no clear evidence that one particular deflator out of the five we investigate outperforms the others.

The second empirical study provides a test for the existence of a “mispricing” effect associated with accounting-based valuation model in the UK. It investigates a specific firm valuation model where market value is expressed as a linear combination of book value, earnings, research and development expenditures, dividends, capital contributions, capital expenditures and other information. All these accounting variables have been found value relevant in prior studies in the UK.

Although firms in the higher deciles tend to have higher abnormal returns than firms in the lower deciles, the difference between the two extreme portfolios (or the hedge returns) are statistically insignificant. As a consequence, accounting-based valuation models do not seem to provide superior estimates of intrinsic value to market values. We
can conclude that the UK stock market is semi-strong form efficient, in the sense that it does not appear to be possible to generate positive abnormal returns based upon publicly available accounting information embedded in the valuation models studied. As a consequence, these models appear suitable for use in value relevance studies in the UK.

7.4 The limitations of the thesis and suggestions for future research

The first limitation of this study could be the valuation models employed in the empirical analysis. It is simply impossible to develop a valuation model that can be defended unequivocally. One possible limitation of the valuation models adopted in this research could be their property of linearity. As a consequence, this potential source of model misspecification could result in erroneous conclusions. Nonetheless, most studies within the field adopt linear relationships between market value and accounting variables which, at least, makes the results of this research comparable to prior studies.

Another limitation arises with the assumption made, for the study of out-of-sample valuation errors, that the model is assumed to be stable across years. This assumption could affect the validity of the empirical results.

For the empirical study concerning fundamental analysis of firm valuation models, one limitation is associated with the performance evaluation of the investment strategies, where there are alternative methods of risk control, such as using benchmark models that are developed on the basis of firm-specific factors, for instance, market capitalization and
book-to-market value. Investigation into alternative risk control methods is necessary for the literature of performance evaluation.

Further, the portfolio strategies employed are relatively simplistic. Certainly, although rankings-based portfolio strategies are commonly found in market-based accounting studies, the search for profitable portfolio strategies cannot be described as exhaustive. As a consequence, it is possible that other strategies can be identified that generate abnormal returns. Should such be the case, transactions costs would have to be considered to estimate the actual profitability of the strategy? Also other holding periods for the trading strategy (for instance, three months or six months) could be considered to examine abnormal returns within shorter window.

Further, due to limitations of data availability, ‘other information’ is estimated using the previous year’s data which could introduce survivorship bias into the sample. It could be interesting to proxy other information using the consensus earnings’ forecast data from IBES. Inclusion of analyst forecast element into the model might also improve the ability to predict intrinsic value in the firm valuation models. Nonetheless, it would reduce the number of firms that could be studied.

Last but not the least, we measure earnings as net income in this study, which essentially assumes that all earnings components carry the same coefficient for equity valuation. Prior studies have shown that decomposition of earnings before RD into two components – earnings before RD and extraordinary/exceptional items and extraordinary/exceptional
items - can add information for loss reversal models (Jiang and Stark, 2009a). Given this predictive power for future earnings, we could also consider using a measure of a component of core earnings, such as earnings before RD and extraordinary/exceptional items, together with extraordinary/exceptional items, to see whether this further decomposition will improve the bias and accuracy of accounting-based valuation models.

7.5 Conclusion

This thesis consists of two empirical studies. The first empirical study uses out-of-sample valuation errors as an alternative metric capturing the effectiveness of various estimation approaches in generating reliable estimates coefficients in accounting-based valuation models and, accordingly, less valuation bias and higher valuation accuracy. It finds that using an expanded model is superior to a base model in which book value and earnings are the only independent variables. It also finds that deflating the full equation including the constant term of the undeflated model and, hence, estimating without a constant term in the deflated model, provides less bias and more accurate value estimates relative to including a constant term in the regression equation. Further, estimating the model separately on low- and high-intangibles firms appears superior to estimating on samples that pool these firms. Evidences also show that including ‘other information’ is superior to omitting it as an independent variable. There is no clear evidence that one particular deflator out of the five we investigate outperforms the others, although book value and opening and closing market value appear to generally perform better than sales and number of shares.
The second study suggests that, using simple in-sample proportional valuation error rankings-based portfolio strategies, no abnormal returns can be generated. This suggests that the UK market is informationally efficient with respect to the information contained in the empirical accounting-based valuation models and that the models do not provide superior estimates of intrinsic value relative to those provided by market values. It also suggests that it is reasonable to use the models examined as a base model for value relevance tests in the UK.
BIBLIOGRAPHY


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