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Simon Hussain.

The Time Profile of Analysts' Earnings Forecasts.

Master of Arts.

1990.

The objective of this thesis is to investigate the part played by analysts in incorporating information about earnings into stock-prices.

Chapter 1 deals with the theoretical background.

Chapter 2 presents the empirical evidence that accounting earnings have information value to the market.

Evidence from chapter 3 indicates that information contained in analysts' earnings forecasts is incorporated into stock-prices. Assuming this to be correct, studying the time-profile of analysts' earnings forecasts gives an insight into the impounding process.

Chapter 4 presents statistical methods for evaluating forecast accuracy and rationality.

Chapter 5 reviews the empirical evidence relating to the accuracy and rationality of analysts' earnings forecasts.

Chapters 6 presents the hypotheses to be tested in the empirical study, and the experimental design.

Chapter 7 presents the results and discusses them in the light of other empirical studies. Shortcomings of the empirical study and suggested further research are then presented.

The Time Profile of Analysts' Earnings Forecasts.

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Master of Arts.

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Department of Economics.

1990.

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INTRODUCTION.

OBJECTIVE.

The objective of this thesis is to investigate the part played by analysts in incorporating information about earnings into stock-prices. This is addressed in two ways. First, a review of the relevant literature is presented. Secondly, a sample of earnings forecasts from a major broking firm is analysed to identify the properties of the forecasts in the months prior to firms' annual announcements.

OVERVIEW.

This study begins by presenting evidence of the role of accounting earnings in bringing information to capital markets. Chapter 1 deals with the theoretical background.

Chapter 2 presents the empirical evidence that accounting earnings have information value to the market, and that much of the information in a forthcoming announcement is anticipated by the market.

Chapter 3 presents evidence that information is impounded into stock-prices through the buy/sell decisions of investors. The chapter also indicates that information contained in analysts' earnings forecasts is incorporated into stock-prices; this may account for the market's anticipation of information contained in forthcoming announcements. On

the assumption that this is correct, studying the time-profile of analysts' earnings forecasts gives an insight into the impounding process, which is usually only observed indirectly through stock-prices.

Chapter 4 presents statistical methods for measuring forecast accuracy, and the properties of the forecast distribution. It describes how the impounding process may be investigated by constructing a time profile of analysts' forecast errors. Also, by constructing a time profile of the mean and variance of the forecast distribution, the chapter describes how the rationality of analysts' forecasts may be investigated.

Chapter 5 reviews the empirical evidence relating to the accuracy and rationality of analysts' earnings forecasts, and the time profile of these forecasts.

Chapter 6 presents the background to the empirical study in this thesis. It describes the data and error metric used in the study, presents the hypotheses to be tested in the study, and describes the experimental design of the study.

Chapter 7 presents the results and discusses the findings in the light of other empirical studies. The conclusions of the empirical study are then presented. A final section provides some shortcomings of the study and suggests further research.

CHAPTER 1.

THE ROLE OF ACCOUNTING EARNINGS IN ASSET VALUATION: A BRIEF REVIEW.

OBJECTIVE.

The objective of this chapter is to document a theoretical link between accounting earnings and asset values. In particular, it suggests that accounting earnings may provide information to the market about future net cash-flows-to-shareholders. This chapter also shows how, assuming market efficiency, this hypothesis may be investigated empirically.

	<u>Chapter sections.</u>	
	The theory of asset valuation.	
	The relationship between accounting earnings, asset prices and expected net future cash-flows-to-shareholders.	
	How asset prices reflect available information; the efficient markets hypothesis.	

THE THEORY OF ASSET VALUATION.

The value of a firm's future accounting earnings, as represented by net-income or earnings-per-share (EPS), is of great interest to investors. Not only are accounting earnings a general measure of a firm's overall performance, but asset-valuation theory indicates that earnings may be

used by the financial community to value capital assets. Firms, or shares in firms, can be valued as the discounted value of the net cash-flows for that asset upon which shareholders have a claim. The value is known as the present value or market value of an asset. Such a model of asset valuation is presented by Fisher (1961). However, the Fisher model assumes perfect certainty about future net cash-flows, which rarely applies to the real world. Sharpe (1964) and Lintner (1965) extend the Fisher model to include uncertainty about future net-cash flows, and this work led to the development of the single-period capital asset pricing model (CAPM). The CAPM incorporates return uncertainty giving the expected return on an asset as a function of both the riskless rate of return (r_f), and a risk-premium.

$$E(r_i) = r_f + [E(r_m) - r_f] \frac{\text{COV}(r_i, r_m)}{\sigma^2(r_m)} \quad \dots 1.1$$

Where r_i = rate of return on the asset i .

r_f = the riskless rate of return.

r_m = return on the market portfolio of assets [this is a portfolio of all the risky assets in the economy which are included in proportion to their market value in relation to the market value of all risky assets].

$E(\)$ = expectations operator.

COV = covariance.

σ^2 = variance.

As r_f is the riskless rate of return, the other term in equation 1.1 can be called the *risk premium*. This is a product of two elements: the

price-per-unit of risk, $[E(r_m) - r_f]$, which is the same for all assets, and the risk Measure (β), $[\text{cov}(r_i, r_m)/\sigma^2(r_m)]$, which varies across assets.

Fama and Miller (1972) present the CAPM as a valuation model providing a direct relationship between asset value and future net cash-flows.

$$V_{i,0} = \frac{E(C_{i,1}) - [E(r_m) - r_f] \left[\frac{\text{cov}(C_{i,1}, r_m)}{\sigma^2(r_m)} \right]}{1 + r_f} \quad \dots 1.2$$

Where $V_{i,0}$ = present or market value of an asset at the beginning of time period t , ($t = 0$).

$E(C_{i,1})$ = expected net cash-flows at the end of time period t , ($t = 1$).

The CAPM may also be applied to a multi-period world but the theory is complex and the single-period model is used to illustrate the link between the present value of an asset and expected net future cash-flows to the asset holder.

THE RELATIONSHIP BETWEEN ACCOUNTING EARNINGS, ASSET PRICES AND EXPECTED NET FUTURE CASH-FLOWS-TO-SHAREHOLDERS.

Although the CAPM provides a theoretical link between future net cash-flows to share-holders (dividends) and the price of an asset, it does not directly provide a link between asset prices and accounting

earnings. Accounting earnings and cash-flows to firms tend to be positively related and because of this, accounting theory sometimes simply assumes that future dividends will be proportionally related to current earnings (i.e. to net cash-flows to firms). Ohlson (1983) describes this assumption as "a particularly severe deficiency.." (p.141). However, Ohlson shows that with a certain set of restrictions, current earnings are indeed "an efficient estimator of future dividends" (p.154), and a later study by Easton (1985) finds a significant correlation between historical cost earnings-per-share and the present value of future dividends.

HOW ASSET PRICES REFLECT AVIALABLE INFORMATION; THE EFFICIENT
MARKETS HYPOTHESIS.

The efficient markets hypothesis (EMH) provides an illustration of the link between accounting earnings and stock-prices. The release of new information concerning cash-flows to shareholders results in analysts competing with each other to trade on this information. As a result of the individual buy/sell decisions of analysts, stock-prices are bid up/down to their new equilibrium prices, which will fully reflect all available information. The EMH assumes that at any time, the present price of an asset fully reflects all available information and is an unbiased estimate of that stock's future value.

Fama (1970) identifies three forms of tests of market efficiency, which differ in the definition of 'available information': *weak form* tests, which define 'available information' as past securities prices

and trading volumes; *semi-strong form tests*, which define 'available information' as all published information, and *strong form tests*, which define 'available information' as all information known by anyone.

Evidence from Fama, Fisher, Jensen and Roll (1969), and Scholes (1969) supports the semi-strong form of the EMH, and Watts and Zimmerman (1986) state that "evidence is consistent with the semi-strong form of the [efficient markets] hypothesis and is generally accepted by researchers as descriptive." (p.19) Early work by Jensen (1968 and 1969) does not find in favour of strong form market efficiency.

In an efficient market, trading in an asset i on available information, an investor is expected to earn the market's expected rate of return for the given level of risk of asset i . Any return beyond this market risk-adjusted rate of return, is termed abnormal. If accounting earnings bring information concerning expected future net cash-flows to shareholders, then if the CAPM holds, a systematic relationship between the unexpected component of earnings announcements (the information of which will not have been incorporated into the pre-announcement stock-price), and abnormal returns on the securities of the firms concerned, may be expected. This provides the basis on which most investigations of the information content of earnings, are designed. Such studies require estimates of the market's expected earnings for a firm i , and the market's expected return on the security i . Earnings forecasts generated by models, or by analysts, are common estimates of expected earnings, and are described in greater detail in chapter 2. Abnormal returns may be estimated using the market model. The market model is described by equation 1.3.

$$r_{it} = \alpha_i + \beta_i E(r_{mt}) + \epsilon_{it} \quad \dots 1.3$$

Where r_{it} = rate of return on asset i in period t .

r_{mt} = rate of return on a market portfolio of assets in period t .

α_i = model parameter.

β_i = return-risk measure for asset i .

ϵ_{it} = abnormal return for asset i , with $E(\epsilon_{it}) = 0$.

The market model abnormal return is the return on an asset which is not explained by market movements, and therefore it is inferred that it is due to unexpected information about the individual asset. Therefore, if abnormal returns occur for firms with an unexpected element in the earnings announcement, it may be concluded that earnings bring information to the market, relating to future net cash-flows-to-shareholders.

Before presenting evidence for the information content of earnings, it should be noted that evidence for the EMH and CAPM, on which the above stock-market reaction study is based, is not entirely conclusive. Indeed, Lev and Ohlson (1982) state that "empirical accounting research has not been particularly supportive of either the ..[EMH].. or the CAPM (p.284)...[and] has indicated the need to be cautious, and conclusions can no longer be regarded as foregone (p.287)."

CHAPTER 2.

THE INFORMATION CONTENT OF EARNINGS; EMPIRICAL EVIDENCE.

OBJECTIVE.

This chapter presents evidence which indicates that accounting earnings bring information to the market relating to future net cash-flows-to-shareholders, as hypothesised in chapter 1. Since empirical studies require estimates of the market's expected earnings for a firm, and the expected rate of return on a security, this chapter also presents evidence on the suitability of different estimates of market expectations. It is concluded that analysts' earnings forecasts provide a superior estimation of the market's expected earnings, compared to time-series or cross-section models, but that the choice of model to estimate the market's expected return appears to be of little significance.

Chapter sections.

Empirical evidence on the relationship between accounting earnings and stock-prices.

Estimating the market's expected earnings.

Estimating the market's expected return.

EMPIRICAL EVIDENCE ON THE RELATIONSHIP BETWEEN ACCOUNTING
EARNINGS AND STOCK-PRICES.

Evidence of an association between the sign of unexpected earnings and the sign of abnormal returns is found by Ball and Brown (1968), and in studies by Foster (1977) and Watts (1978) which develop the Ball and Brown methodology. Summaries of these studies are given below.

Ball and Brown (1968).

The path-breaking work in the investigation of a link between accounting earnings and stock-prices is the study by Ball and Brown (1968).

The study investigates monthly stock-returns in the twelve months preceding an annual earnings announcement and in the six months after the announcement. The market's expectation of earnings is estimated using a simple 'naive' model described by equation 2.1.

$$\hat{\Delta Z}_{it} = \hat{a}_{1it} + \hat{a}_{2it}\Delta M_{it} \quad \dots 2.1$$

Where $\hat{\Delta Z}_{it}$ = predicted change in annual earnings for firm i, year t.

$\hat{a}_{1it}, \hat{a}_{2it}$ = estimated model parameters.

ΔM_{it} = change in average earnings of all firms in the market (except firm i) in year t.

The unexpected earnings for a firm i in year t is estimated as the difference between the actual change in income in year t and the change

predicted by the model. From these estimates of unexpected earnings, all firm-year combinations are then divided into two sub-sets: one for those firm-years for which unexpected earnings are positive, and one for those firm-years for which unexpected earnings are negative.

Estimates are then obtained for the abnormal returns on the stocks of these companies for the 18 months surrounding the earnings announcement in year t . Ball and Brown estimate abnormal returns using a model based on the market model (see Ball and Brown, 1968. pp.162-163). Monthly abnormal returns are estimated for each firm, starting from the twelfth month prior to the announcement through to the sixth month after (i.e. for months $T = -11, \dots, 0, \dots, +6$). For a firm i , $\hat{e}_{i,t}$ is the abnormal rate of return in the announcement month. The average abnormal returns for the Q firms in the two sets of firm-years, from month -11 to month T , are measured by the abnormal performance index (API), described by equation 2.2.

$$API_T = 1/Q \sum_{q=1}^Q \prod_{t=-11}^T (1 + \hat{e}_{qt}) \quad \text{where } T = -11, \dots, 0, \dots, +6 \quad \dots 2.2$$

It is found that for the positive unexpected earnings sub-set, the API increases steadily from 1.00 at the beginning of the period ($T = -11$), to 1.05 for the month of the announcement ($T = 0$). For the negative unexpected earnings sub-set, the API declines steadily from 1.00 at time $T = -11$, to 0.89 for the announcement month ($T=0$). These results indicate that accounting earnings bring information concerning future net cash-flows-to-shareholders, and that the market anticipates much of

this information. Indeed, the change in the API from month -1 to month 0 (the announcement month) indicates that only about 10-15% of the potential information that the earnings announcement contains is new to the market in the month of the announcement.

Later studies develop the Ball and Brown (1968) methodology. Watts (1975) finds that the quarterly earnings process may follow an autoregressive process which may be estimated using Box and Jenkins (1970) methodology. This may provide a superior estimate of the market's expected earnings. Also, the use of quarterly data may provide a less 'contaminated' estimate of the proportion of information in earnings announcements that is new to the market. This is because the Ball and Brown (1968) study estimates the proportion of new information in annual announcements. But new information brought by interim announcements earlier in the fiscal year may have already been incorporated prior to the annual announcement, thus reducing the estimate of the proportion of information in announcements that is new. Both Foster (1977) and Watts (1978) use Box-Jenkins models to estimate the market's expected quarterly earnings.

Foster (1977).

Foster uses an autoregressive model to provide estimates of the market's expectation of quarterly earnings, and finds a systematic relationship between the sign of unexpected earnings and abnormal returns.

Foster uses past quarterly earnings data from each firm, and Box-Jenkins methodology, to estimate the first-order autoregressive expectations model described by equation 2.3.

$$\hat{Z}_{i,t} = Z_{i,t-4} + \phi(Z_{i,t-1} - Z_{i,t-5}) + \delta \quad \dots 2.3$$

Where $\hat{Z}_{i,t}$ = estimated value for the expected quarterly earnings of firm i for period t

ϕ = autoregressive parameter

δ = drift term

From the above model's estimates, firm-quarter observations are then divided into a group for firm-quarters with positive unexpected earnings, and a group for firm-quarters with negative unexpected earnings. For each security, Foster obtains daily abnormal returns for the 60 trading days up to, and including, the day that the quarterly earnings are announced (i.e. from $t = -59$ to $t = 0$). The abnormal performance measure used by Foster, which is a similar measure to Ball and Brown's API, is the cumulative abnormal return (CAR). (A description of the abnormal returns estimation method used by Foster, and the CAR, is given by Watts and Zimmerman, 1986, p.50).

Foster finds that the CAR over the 60 trading days, for the group of firm-quarters with positive unexpected earnings, is positive (+2 %), while for the group of firm-quarters with negative unexpected earnings, the CAR is negative (-3 %), supporting the hypothesis of a link between accounting earnings and stock-prices. However, Foster estimates that the proportion of information in earnings announcements that is new to the market, is about 32%, indicating greater informativeness compared to

the findings of Ball and Brown (1968). Using the χ^2 test, Foster then tests the null-hypothesis that there is no relationship between the sign of the unexpected earnings, and the sign of the abnormal rate of return. It is found that the null-hypothesis can be rejected at any reasonable level of probability.

Watts (1978).

Watts (1978)(p.134) criticises the use of the χ^2 test by Foster (1977), used to test (and subsequently reject) the null-hypothesis of no relationship between the sign of the unexpected earnings (i.e. the forecast error) and abnormal returns for the given firm-quarter. An assumption of the χ^2 test is that there is no cross-sectional dependence between the variables (one of which is the earnings forecast error). However, studies such as that by Brown and Ball (1967) have shown that earnings do show cross-sectional dependency.

This paper investigates the link between quarterly unexpected earnings and abnormal returns in the quarters surrounding the quarterly announcement, taking the above criticism, and others made by Ball (1978), into account. However, Watts still concludes in favour of the information content of earnings.

Watts uses three Box-Jenkins models to estimate expected earnings, one of which is the Foster (1977) model described above. (see equation 2.3). The second model used by Watts is a model used in studies by Watts (1975) and Griffin (1977) to model the quarterly earnings process.

$$E(Z_t) = Z_{t-1} + (Z_{t-4} - Z_{t-5}) - \theta\alpha_{t-1} - \gamma\alpha_{t-4} + \theta\gamma\alpha_{t-5} + \delta \quad \dots 2.4$$

Where $E(Z_t)$ = expected earnings for quarter t.

Z_{t-1} = actual earnings for quarter t-1.

θ = moving-average parameter.

γ = seasonal moving-average parameter.

δ = a constant.

α_t = serially uncorrelated error term for period t.

The third model is one estimated by Brown and Rozeff (1979), a study which also models the quarterly earnings process.

$$E(Z_t) = Z_{t-4} + \phi(Z_{t-1} - Z_{t-5}) - \gamma\alpha_{t-4} + \delta \quad \dots 2.5$$

Where ϕ = an autoregressive parameter.

Dividing firm-quarters into "positive" and "negative" unexpected earnings sub-sets, for each of the three earnings expectation models, Watts estimates abnormal quarterly returns using an adaptation of the Black and Scholes (1973) paired sample design (see Watts p.130). Abnormal returns are calculated for the quarters q ($q = -1, 0, \dots, 5$), where $q = 0$ is the quarter ending at the end of the week of announcement. Watts then constructs a t-statistic to test the null-hypothesis that there are no abnormal returns in quarter q ($q = -1, \dots, 5$). The tests are carried out for each of the "positive"/"negative" unexpected earnings groups of firm-quarter observations created using the three earnings models described earlier.

For all three of the expectations models the null-hypothesis of no abnormal returns is rejected for the quarters $q = -1, 0$ and 1. The

strongest rejection of the null-hypothesis is for the quarter 0 (the announcement quarter) providing evidence in support of there being a link between accounting earnings and stock-prices as indicated by Ball and Brown (1968) and Foster (1977). The null hypothesis is also rejected, less strongly, for the quarters -1 and 1, possibly indicating 'leakage' of information to the market prior to the announcement, and market inefficiency, respectively.

The results are in agreement with the findings of Ball and Brown (1968) and Foster (1977) which indicate that the unexpected component of accounting earnings may bring new information to the market about future net cash-flows-to-shareholders.

The power of tests used in the above studies may be greatly influenced by the estimates of the market's expectation of earnings and the market's expected return on a security. The following two sections provide evidence that analysts' earnings forecasts are a superior estimate for market's expected earnings, than mechanical model forecasts; and that simple expected returns models may provide estimates of abnormal returns that are at least as good as those derived from more complex expected returns models. Evidence on estimating the markets's expected earnings, and expected return, is presented below.

ESTIMATING THE MARKET'S EXPECTED EARNINGS.

Brown and Rozeff (1978) state that "If market earnings expectations are rational, it follows that the best available earnings forecasts should be used to measure market earnings expectations." (p.13).

If accounting earnings bring information to the market, the earnings expectation model/source which produces forecast errors (i.e. estimates of unexpected earnings) which are the most strongly related to the corresponding abnormal returns, may be considered to be the better estimate of the market's expectation of earnings. The results of studies are presented below.

Fried and Givoly (1982).

This study compares annual unexpected earnings estimates (i.e. forecast errors) from two models (a time-series model, 2.6, and an index model, 2.7), and from analysts (the "Earnings Forecaster").

$$E(Z_t) = Z_{t-1} + c_t \quad \dots 2.6$$

Where $E(Z_t)$ = expected annual earnings for year t.

Z_{t-1} = actual earnings for year t.

c_t = drift term equal to the arithmetic past growth in EPS.

$$E(Z_t) = Z_{t-1} + \alpha_t + \beta_t Z_{mt} \quad \dots 2.7$$

Where α_t and β_t = regression coefficients.

Z_{mt} = change in the market index of earnings, represented by the Standard and Poor 500.

Fried and Givoly (1982) find that abnormal returns are more strongly correlated with the analysts' forecast errors than with the errors generated by either of the models.

Brown, Griffin, Hagerman and Zmijewsky (1987).

This study finds similar results to Fried and Givoly (1982), providing further evidence for the superiority of analysts' forecasts as a measure of market expectation of earnings.

However, the conclusions of Fried and Givoly (1982) and Brown, et al. (1987) are not supported by the findings of O'Brien (1988).

O'Brien (1988).

O'Brien obtains annual earnings forecasts at four different forecast horizons; 240, 180, 120 and 60 days. The market's expected earnings are represented by three different analyst forecasts (the most recent analyst forecast available at the given horizon, and the mean and median of analysts' forecasts available at the given horizon) and by forecasts generated using the Foster (1977) model (see equation 2.3 above). O'Brien then estimates the cumulated abnormal returns, starting from

each forecast horizon date to the annual announcement date (see O'Brien p.62). For each of the four forecast horizons, the Foster (1977) model generates forecast errors that are more strongly related to cumulative abnormal returns than the forecast errors generated by the three sets of analysts' forecasts. O'Brien admits that this finding "is inconsistent with previous research, and is anomalous given analysts' greater accuracy." (p.53)

A possible explanation for the O'Brien (1988) findings is that, because different investors give different weightings to different analysts' forecasts (and these different expectations are incorporated into stock-prices through 'dollar votes'), a simple generating model such as a Box-Jenkins model may better represent the market's overall expectation than the specific forecasts of individual analysts. However, this explanation would suggest that the mean or median analyst forecast should be more strongly related to abnormal returns than the most current forecast (an individual analyst's forecast). O'Brien does not find this to be the case.

Although not entirely conclusive, the above evidence strongly points to analysts' earnings forecasts providing superior estimates of the market's expected earnings.

ESTIMATING THE MARKET'S EXPECTED RETURN.

Stock-price reaction studies require methods for estimating abnormal returns. The ability of models to identify abnormal returns may greatly

affect the power of tests used in such studies. Brown and Warner (1980) investigate how well abnormal performance can be identified by different expected returns models.

Brown and Warner (1980).

The study finds that simple expected returns models may provide estimates of the market's expected return that are at least as good as those derived from more complex models. The study collects observed stock-returns of randomly selected securities. On average it would be expected that the returns would not display abnormal performance (efficient market theory suggests that the abnormal returns will, over all time periods, average to zero). Artificial abnormal returns are then introduced into the data. The value of the abnormal return on a security depends on the expectation model used for generating the expected rate of return. Brown and Warner compare three models;

(1) The Mean Adjusted Returns model. This model assumes that the expected return on a security for time t will be a constant (K), but this constant varies across securities so the expected return on security i is given by;

$$E(R_i) = K_i \quad \dots 2.8$$

The abnormal return ($e_{i,t}$) is given by the difference between the expected rate of return and the observed rate ($R_{i,t}$);

$$e_{i,t} = R_{i,t} - K_i \quad \dots 2.9$$

(2) Market Adjusted Returns model:- This assumes expected returns for

period t are equal across securities but are not necessarily constant for a particular security. The market portfolio (M) is a linear combination of all risky assets, hence, for any security i ,

$$E(R_{i,t}) = E(R_{m,t}) = K_t \quad \dots 2.10$$

The abnormal return in period t is the difference between the return on the asset i and that on the market portfolio;

$$e_{i,t} = R_{i,t} - R_{m,t} \quad \dots 2.11$$

(3) Market and Risk Adjusted Returns model:- This assumes that expected returns are generated by a model similar to the Black (1972) 2-parameter CAPM.

$$E(R_{i,t}) = E(R_{z,t}) + \beta_i [E(R_{m,t}) - E(R_{z,t})] = K_{i,t} \quad \dots 2.12$$

$$e_{i,t} = R_{i,t} - [R_{z,t}(1 - \beta_i) + \beta_i R_{m,t}] \quad \dots 2.13$$

Where $R_{z,t}$ = return on a minimum variance portfolio of risky assets which is uncorrelated with the market portfolio.

Ordinary least squares regression is used to estimate model parameters. All models are consistent with the CAPM, given certain assumptions. However, if the CAPM is correct, the market and risk adjusted returns model may provide a superior estimate of the market's expected return, since it incorporates more information affecting realised returns.

Brown and Warner test the null-hypothesis of no abnormal returns, for samples of randomly selected securities returns with abnormal returns of 0, 1 and 5 % artificially introduced. The three significance tests

used to test the null-hypothesis are the t-test, the Sign test and the Wilcoxon signed rank test.

Analysing the rate at which the null-hypothesis is rejected using each of the three expectation models, Brown and Warner (1980) conclude that the mean adjusted returns model performs just as well at identifying abnormal returns, if not better, than the more complicated models.

Evidence presented in this chapter indicates that there is an association between the sign of unexpected earnings and abnormal returns. Assuming returns are generated by a model consistent with the CAPM, it may be concluded that accounting earnings contain information relating to future net cash-flows-to-shareholders.

Studies by Ball and Brown (1968) and Foster (1977) indicate that although earnings announcements may bring some new information to the market, much of the announcement information is incorporated, or impounded, into stock-prices prior to the announcement. The finding that analysts' earnings forecasts appear to be superior estimates of market expectations indicates that the market may impound information contained in analysts' forecasts and, thus, anticipate information contained in forthcoming announcements. The next chapter investigates the process by which information may become impounded into stock-prices.

CHAPTER 3.

THE PROCESS BY WHICH ACCOUNTING INFORMATION IS INCORPORATED INTO

STOCK-PRICES.

OBJECTIVE.

This chapter investigates the process by which information is impounded into stock-prices. In an efficient market, information is instantly impounded into stock-prices through market forces, as individual traders buy and sell stocks in an attempt to profit from the information release. This chapter presents evidence of the impounding of information from earnings announcements into stock-prices. Evidence is then presented that information incorporated in analysts' earnings forecasts becomes impounded into stock-prices. Evidence for the differential information hypothesis, which relates to the influence of firm size on information production, is then presented, .

Chapter sections.

Introduction.

The process of impounding accounting information; empirical evidence.

The impounding of information contained in analysts' earnings forecasts; empirical evidence.

The differential information hypothesis, with empirical evidence.

Conclusion; the role of analysts' forecasts in studying the impounding process.

INTRODUCTION.

If earnings bring information to the market concerning future net cash-flows-to-shareholders then, once earnings are announced, traders with this knowledge have an incentive to sell shares in firms with earnings that are less than the market expectation and buy shares in firms with earnings that are greater than the market expectation. The earlier the purchase of the stock of a firm which has just announced earnings that are greater than expected, the larger the return that the trader will obtain from the share when it finally reaches its new equilibrium price. Conversely, it is important for traders to sell stocks in firms that have announced earnings that are less than expected, as quickly as possible. Eventually, through the individual buy/sell decisions of traders, the stocks will arrive at a new equilibrium price which, assuming market efficiency, will fully reflect all information contained in the earnings announcement.

THE PROCESS OF IMPOUNDING ACCOUNTING INFORMATION: EMPIRICAL EVIDENCE.

The process of impounding information into stock-prices is not directly observable, but may be studied by analysing changes in stock-prices, or traded volume of stocks, around the period of an earnings announcement. As information is impounded into stock-prices through market forces, the impounding process may be indicated by increased trading volumes and

price changes. The following evidence from Patell and Wolfson (1984), Jennings and Starks (1985) and Woodruff and Senchack, Jr. (1988) indicates that information that may be contained in earnings announcements, is almost fully impounded within several hours of an announcement.

Patell and Wolfson (1984).

Patell and Wolfson (1984) find that much impounding occurs in the first thirty minutes after an announcement, and that the process is virtually completed within four hours of the announcement. They investigate the time period for which abnormal returns can be earned, after a positive unexpected earnings announcement, with quarterly and annual Value Line Investment Survey (i.e. analysts') forecasts used as the market expectation. They also investigate the number of "extreme" (Patell and Wolfson, 1984, p.237) price changes, around the time of announcement. Comparisons are made with 'control' group data randomly selected from non-announcement times.

The results of the first part of the study indicate that while no abnormal returns occur 60 to 90 minutes before an earnings announcement, positive abnormal returns do occur in the thirty minutes after an announcement. There is also evidence of positive abnormal returns in the overnight period and in the first 30 minutes of the following day, possibly indicating the dissemination of the announced information to smaller investors.

Patell and Wolfson then investigate "extreme" price changes in discrete hourly periods around the announcement. The significance of

the number of extreme values for each period (from 10 hours before announcement to 15 hours later) is then tested using the Z-test. Significant numbers of extreme price changes are found for periods 0 to 4 (i.e. for the hour beginning at the time of announcement, to the hour beginning four hours after the announcement), and some activity is suggested for the hour preceding the announcement.

Jennings and Starks (1985).

This study suggests that the impounding process may last between seven and nine hours, with the length of time varying with the proportion of the unexpected earnings component. This is a similar study to Patell and Wolfson (1984), but divides stocks into 'high information' announcements and 'low information' announcements, depending on the size of the unexpected component in the earnings announcement, with 'Value Line' and 'Earnings Forecaster' forecasts used as market expectations. Three different definitions of 'high' and 'low' information announcements are used in the study (Jennings and Starks, 1985, p.343) but results are similar for all three definitions.

Jennings and Starks investigate the number of "extreme" (Jennings and Starks, 1985, p.346) price changes over discrete one-hour periods, from hour -3 relative to the announcement hour, to hour +10. Studying the significance of the numbers of 'extreme' price changes, it is concluded that the impounding process takes eight or nine hours (beginning between one or two hours prior to the announcement) for 'high' information stocks, and about seven hours (starting between the hour

prior to announcement and the second hour after announcement) for 'low' information stocks.

Woodruff and Senchack, Jr. (1988).

This study concludes that the impounding process may occur more quickly when unexpected earnings are positive. The study investigates differences in the speed of stock-price adjustment for 5 announcement groups, each representing different "degrees of surprise" in an earnings announcement, where degree of surprise (U) is given by,

$$U = \frac{\text{Actual earnings} - \text{Expected earnings}}{\text{Expected earnings}} \quad \dots 3.1$$

Expected earnings for each firm-quarter are estimated by analysts' forecasts from the "Value Line Investment Survey", also used by Patell and Wolfson (1984) and Jennings and Starks (1985). Firm-quarters are divided into different "earnings surprise" categories, depending on the value of U, these categories being "most favourable", "less favourable", "less unfavourable" and "most unfavourable", where "favourable" ("unfavourable") refers to positive (negative) unexpected earnings.

Using the stock-price at the end of the first trading day that follows the announcement day as the "fully adjusted" price, it is found that the percentages of the "fully adjusted" price change that have already occurred within thirty minutes of an earnings announcement for the most favourable and less favourable categories is 69% and 51%, respectively, while for both the less unfavourable and most unfavourable categories it is only 38%. Three hours after the announcement, most favourable and

less favourable stocks have achieved 91% and 76%, respectively, of their full adjusted price changes, while less unfavourable and most unfavourable stocks have both reached only two-thirds of their fully adjusted price change.

The evidence above illustrates the process of incorporating information from earnings announcements, into stock-prices. In an efficient market, the impounding process is occurring all the time, as investors continually trade on information that becomes available. One of the main sources for accounting information, are analysts. In particular, analysts provide forecasts of firms' future earnings. If investors trade upon these forecasts, the information contained in the forecasts may become incorporated into stock-prices via the same impounding process that incorporates information from earnings announcements.

THE IMPOUNDING OF INFORMATION CONTAINED IN ANALYSTS' EARNINGS FORECASTS:
EMPIRICAL EVIDENCE.

Atrill and McLaney (1987) state that "It has been claimed that stock-brokers' analysts are responsible for a significant proportion of the original research carried out in the equity market and that their findings are communicated to and used by virtually all active institutional investors." (p.29) and cite Dimson and Marsh (1984) as the basis for this statement.

Evidence from studies presented below indicates that changes in analysts' earnings forecasts mirror the changes in stock-prices,

implying that an impounding process is occurring. They show a positive association between the sign of cumulative abnormal returns in the twelve months preceding a forecast revision by analysts, and the sign of the forecast revision. The continued employment of analysts may suggest that they trade on their revised forecasts, prior to publishing the revision, hence abnormal returns are found prior to the revised-forecast publication.

Finn (1981), Elton, Gruber and Gultekin (1981), Abdel-khalik and Ajinkya (1982).

Finn finds that "both the direction and magnitude of the forecast [revisions] were positively related to excess return behaviour over the 12 month period up to [the] month [of the revision]." (p.29). Elton, Gruber and Gultekin (1981) and Abdel-khalik and Ajinkya (1982) also find abnormal returns in the months preceding a forecast revision, of the same sign as the revision.

Brown, Foster and Noreen (1985)

Brown, Foster and Noreen (1985) find that there is a positive association between the sign of a revision in analysts' consensus one-year-ahead forecasts, represented by the mean and median forecasts, and the sign of average cumulative abnormal returns over the twelve months preceding the revision. Brown, et al. present five possible explanations for why abnormal returns may precede a forecast revision.

(1) Security prices impound information not yet available to analysts through, for example, insider dealing by management.

(2) Security analysts are less efficient processors of publicly available information than the aggregate capital market.

(3) Security analysts trade on their own information before releasing their revision to the market.

(4) There are severe time lags between individual analyst revisions being made public and their inclusion in consensus forecast data bases.

(5) Analysts use security price changes as signals to revise forecasts in the same direction.

Option (3) may be a strong possibility as there may be little opportunity for an analyst to earn abnormal returns by trading after releasing a forecast revision to the market. Although the other options are also possibilities, as Brown, Foster and Noreen (1985) state; "It would be difficult to explain ...the continued employment of analysts to forecast earnings if all they are doing is re-expressing, in an earnings format, the information already available in a publicly observable datum such as a security price". (pp.139-140).

The evidence indicates that information reflected in analysts' earnings forecast revisions may become impounded into stock-prices. It is not known whether this process occurs as a result of the revision or prior to the revision. However, the continued employment of analysts

may indicate the former to be true. The impounding of analysts' information is discussed in the following section.

THE DIFFERENTIAL INFORMATION HYPOTHESIS, WITH EMPIRICAL EVIDENCE.

The differential information hypothesis (DIH), proposed by Atiase (1980) suggests that information production and dissemination by analysts is an increasing function of firm size. The possible reasons for this are presented in section 6.3 of chapter 6. Assuming analysts' information is impounded into stock-prices, and that the DIH is correct, then it may be that the allocation of a nation's capital resources to small firms is sub-optimal compared to resource allocation to large firms.

The results of Atiase (1985), Bamber (1986) and Freeman (1987) support the DIH, and summaries of these studies are presented below. Investigations of the hypothesis are usually carried out by testing inferences of the hypothesis. This may be because the hypothesis deals with information production and dissemination, which are factors that may be difficult to directly observe.

Atiase (1985).

Atiase finds that although return variances for larger firms do not change significantly during the announcement week, significant increases do occur in the return variances of smaller firms in the announcement

week. This suggests that the proportion of announcement information that is anticipated by the market, is greater for larger firms.

Bamber (1986).

This study finds that the increase in the trading volume of small firms' securities in the announcement week is greater than the increase in the trading volume for larger firms' securities.

Freeman (1987).

This study finds that stock-prices for larger firms reflect announcement information at a greater forecast horizon (the timing hypothesis) and that for larger firms a greater proportion of announcement information is anticipated by the market, prior to the announcement (the magnitude hypothesis).

The study divides firms into "large" (average market value \$2.8 billion) and "small" (average market value of \$46 million), with the relevant values being derived from upper and lower quartiles for firms from the COMPUSTAT tapes. Two inferences of the DIH are investigated.

The timing hypothesis: The abnormal security returns related to accounting earnings occur (begin and end) earlier for large firms than for small firms.

The magnitude hypothesis: The magnitude of those abnormal returns is inversely related to firm size.

Using several statistical tests (including Wilcoxon sign rank test, matched pair t-test and the Kolmogorov-Smirnov test) Freeman concludes that the null-hypotheses of the timing and magnitude hypotheses, should be rejected.

Freeman (1987) finds that "pooled abnormal returns of large firms...begin to reflect earnings changes 22 months before fiscal year end...(but)...the abnormal returns for small firms...is detected 3 months later" (p.195), providing evidence for the timing hypothesis.

Freeman also finds that "cumulative abnormal returns of small firms ultimately exceeded the total for large firms by 44 %." (p.196), which may provide evidence for the magnitude hypothesis.

As the timing and magnitude hypotheses are corollaries of the differential information hypothesis (DIH), Freeman's findings may provide evidence in support of the DIH.

The above evidence on the DIH is consistent with the results that would be expected if analysts' information becomes impounded into stock-prices, assuming information production to be an increasing function of firm size.

CONCLUSION: THE ROLE OF ANALYSTS' FORECASTS IN STUDYING THE
IMPOUNDING PROCESS.

This chapter presents evidence for a relationship between analysts' earnings forecasts and stock-prices. Evidence that this association has a logical basis and is not merely a statistical phenomenon, is provided

by findings to be presented in chapter 5. The findings show that analysts' earnings forecasts are superior information sources compared to forecasts by either statistical models or firm management. Consequently, this result allows analysts' forecasts to be employed as a proxy for market expectations in the study of the process by which information is incorporated into stock-prices. Therefore, by studying the time profile of analysts' forecast errors, the impounding process may be investigated.

However, if analysts' forecasts are to be studied, methods for their evaluation are required. The following chapter presents statistical methods which may be used to evaluate the forecasts.

CHAPTER 4.

METHODS FOR EVALUATING ANALYSTS' EARNINGS FORECASTS.

OBJECTIVE.

Chapter 3 shows that information in analysts' earnings forecasts is impounded into stock-prices. As a result, the properties of analysts' earnings forecasts are of importance. Two important properties of forecasts are accuracy and rationality. The first section of this chapter presents methods for evaluating forecast accuracy. The second section presents methods for evaluating forecast rationality by investigating bias and variance of the forecast distribution. These methods may be used to identify a superior forecaster. The benefit for society of being able to identify a superior source of earnings forecasts is that all market participants can then use this source of information, and stocks can be valued accordingly. (For the possible limitations on the benefits of identifying a superior forecaster, see Figlewski, 1978).

The third section of this chapter describes how changes in accuracy over time may illustrate the impounding process, and how changes in the forecast distribution over time may demonstrate forecast rationality.

<u>Chapter sections.</u>	
Evaluating forecast accuracy.	
Evaluating forecast rationality.	
The time profile of analysts' forecasts.	

EVALUATING FORECAST ACCURACY.

Although an investor will prefer a more accurate earnings forecast to a less accurate one, in order to decide which measures of accuracy to use, it is necessary to discuss the loss of utility, or dis-utility, that the economic agent (i.e. the investor) experiences from an incorrect forecast. The loss concept measuring the disutility associated with a forecast error is presented below.

The concept of loss is the concept of disutility, i.e. the opposite of utility. The term utility is often used in economics to refer to the satisfaction that an individual obtains from a certain good or combination of goods. The concept requires the following assumptions, known as axioms, to be made about the way people behave;

(1) Individuals have the ability to rank different goods A and B.

The axiom of *completeness*.

(2) Individuals display *transitivity* in their decision making. If they prefer A to B, and B to C, then they must prefer A to C.

The axiom of *transitivity*.

(3) The individual aims to achieve the maximum possible utility value that can be achieved with the choices available.

The axiom of *selection*.

(4) The individual will prefer more of a good to less.

The axiom of *dominance*.

The measure of the individual's utility is the utility index (U) which is generated by a utility function which can be written in the general manner below.

$$U = U (A, B, C) \quad \dots 4.1$$

This states that the utility index is a function of the amounts of the goods A, B and C. However, the concept of diminishing marginal utility means that the utility increase that accompanies each extra unit of a certain good (A), diminishes. Hence, the utility function which shows utility as a function of the amount of good A is not a simple linear function and may be written as a quadratic equation i.e.

$$U (A) = a_1 + a_2 A - a_3 A^2 \quad \dots 4.2$$

It follows that if the utility function is quadratic, then the measure of disutility, or the loss function, will also be of a quadratic type. Each extra unit of a good that is lost will result in larger and larger decreases in the utility index. An increasing marginal loss is associated with each extra unit of a good that is lost.

The concept of utility/disutility may be applied to the policy maker of a business who has a desired value for two related variables. Assume these to be accounting earnings (Y) and advertising expenditure (X).

It may be assumed that the true relationship is a simple one such that;

$$Y = a + b X \quad (b > 0) \quad \dots 4.3$$

where a represents an aggregate effect of all other factors.

(the above equation would apply to a time-period t or an observation i but the subscripts t and i have been omitted for simplicity).

The policy maker has desired values for earnings and advertising expenditure of μ and π , respectively. However, it may be that the two desired values are not consistent i.e. attainable simultaneously.

It may be assumed that the decision maker will want to minimise a weighted sum of the squares of the differences between the desired and attainable values for the two variables. For this a loss function or disutility function is created with coefficients based on the policy maker's preferences.

$$l(X,Y) = h (X - \pi)^2 + k (Y - \mu)^2 \quad (h, k < 0) \quad \dots 4.4$$

The above loss equation (4.4) has to be minimised subject to the

equation (4.3). This produces another loss function;

$$l^*(X) = k(\mu - a - b\pi)^2 - 2kb(\mu - a - b\pi)(X - \pi) + (h + kb^2)(X - \pi)^2 \quad \dots 4.5$$

The loss function above is minimised unconditionally with respect to the controlled variable, advertising expenditure (X);

$$X^o - \pi = \frac{kb}{h + kb^2} (\mu - a - b\pi) \quad \dots 4.6$$

The optimal decision (X^o) is shown as a deviation from the desired value of π . The (minimum) value of the loss function associated with the optimal value of X^o is;

$$l^*(X^o) = \frac{hk}{h + kb^2} (\mu - a - b\pi)^2 \quad \dots 4.7$$

In order to minimise the loss function the policy maker selects the value for advertising expenditure so that the values of X and Y are as close to their desired values as can be possible at the same time.

If a has to be estimated the decision that is made will be optimal only if the estimated and true values of a are the same. Using equation (4.6) the loss associated with the forecast, \hat{a} , is;

$$X - \pi = \frac{kb}{h + kb^2} (\mu - \hat{a} - b\pi) \quad \dots 4.8$$

If the forecast for a is not the same as the true value of a then the decision that will be taken by the policy maker will be sub-optimal and

will lead to a greater loss than that associated with the optimal value of X^0 . The loss when the forecast and the true value are not the same (i.e. when $\hat{a} \neq a$) is given by substituting the X of (4.8) into equation (4.5);

$$\text{loss when } \hat{a} \neq a = \frac{h k}{h + k b^2} (\mu - a - b \pi)^2 + \frac{k^2 b^2}{h + k b^2} (\hat{a} - a)^2$$

The loss due to the incorrect forecast exceeds the loss associated with the optimal decision, which is given by (4.7), by;

$$l^{**}(\hat{a} - a) = \frac{k^2 b^2}{h + k b^2} (\hat{a} - a)^2 \quad \dots 4.9$$

The excess loss shown by (4.9) is the loss associated with the forecast or prediction error. It can be seen that, assuming a quadratic disutility function, the loss is proportional to the square of the error.

The form of the loss function need not be quadratic as in the above example. An alternative is a linear loss function. Different error metrics correspond to different loss functions. However, Brown, Foster and Noreen (1985) state that "It is ... well recognized that we [i.e. accounting researchers] have limited knowledge of investor loss functions associated with the use of earnings forecasts.." (p.120) and it is the case that no single error measure dominates all investigations into earnings forecast accuracy.

Methods for measuring the accuracy of an earnings forecast for a firm i , in time period t , are presented below. Both the error metrics presented are 'scaled'. This should allow comparison of the accuracy of forecasts relating to different firms. The error metrics are the absolute proportionate forecast error (APFE), corresponding to a linear loss function, and the squared proportionate forecast error (SPFE), corresponding to a quadratic loss function.

This APFE is related to the forecast error in a linear manner and, therefore, corresponds to a linear loss function. It is used in studies by Basi, Carey and Twark (1976), Brown and Rozeff (1978), Ruland (1978) and Patz (1989).

$$APFE_{it} = \frac{|F_{it} - A_{it}|}{|A_{it}|} \quad \dots 4.10$$

Where $APFE_{it}$ = absolute proportionate forecast error for firm i period t

F_{it} = predicted earnings for firm i , period t .

A_{it} = actual earnings for firm i , period t .

The SPFE is related to the squared forecast error, and therefore corresponds to a quadratic loss function, with greater weight being given to larger forecast errors. It is used by Basi, Carey and Twark (1976).

$$\text{SPFE}_{i,t} = \frac{(F_{i,t} - A_{i,t})^2}{(A_{i,t})^2} \quad \dots 4.11$$

Definitions as for APFE.

EVALUATING FORECAST RATIONALITY.

One of the properties usually associated with rational forecasts is that expectations fully reflect all available information at the time the forecast is made.

If X is a continuous random variable, the expected value is given by;

$$E(X) = \int_a^b X f(X) dX \quad \dots 4.12$$

where a and b are the lower and upper limits, respectively, of the random variable.

When the expectation of X for time t , made at a time $t-1$, is conditional upon the currently available information set I_{t-1} , the conditional expectation of X is given by;

$$E(X) = E[X_t | I_{t-1}] = \int_a^b X_t f(X_t | I_{t-1}) dX_t \quad \dots 4.13$$

The forecast error, ϵ_t , for a conditional expectation or forecast, is;

$$\epsilon_t = X_t - E[X_t | I_{t-1}] \quad \dots 4.14$$

The forecast error has two important properties;

1. Since the forecast of X_t , made at $t-1$, is the conditional expectation of X_t , made at $t-1$, the conditional expectation of the forecast error is zero;

$$E[\epsilon_t | I_{t-1}] = E[X_t | I_{t-1}] - E[X_t | I_{t-1}] = 0 \quad \dots 4.15$$

2. Forecast errors should be uncorrelated with any available information, since, if this were not the case, forecasts could be improved by incorporating this correlation. Forecast errors should be unrelated to any information available at the time the forecast is made. This property is known as the orthogonality property and may be described thus;

$$E[\epsilon_t \cdot I_{t-1} | I_{t-1}] = 0 \quad \dots 4.16$$

If an individual's subjective expectation, denoted ${}_{t-1}X_t^e$,

for a variable X_t , equals the conditional expectation for X_t , then the individual's expectation or forecast is rational.

$${}_{t-1}X_t^e = E[X_t | I_{t-1}] \quad \dots 4.17$$

Sheffrin (1983) (pp.18-19) discusses these and other tests for rationality in forecasts. However, two important properties of rational forecasts are that they are unbiased and efficient. Methods for measuring bias and efficiency are presented below.

Strictly speaking, bias is a property of estimators (the formula or procedure by which estimates are calculated), rather than estimates. Most studies investigating bias, with regard to earnings forecasts, refer to bias as a property of forecasts. Terms such as 'forecast bias' are convenient and will be used throughout this thesis, but it should be remembered that bias is a property of estimators. An estimator is unbiased if the the difference between the expected value of the estimator and the true parameter value, is zero.

$$\text{Bias} = E(\hat{A}) - A = 0 \quad \dots 4.18$$

Theil (1966) presents a method, described below, for measuring the contribution of bias to the forecast error.

It may be assumed that a realised change (A_t) consists of a systematic part, which is generated by some mechanical relationship, and an unsystematic part, which shows the net effect of random disturbances. Hence, if a forecaster has perfect knowledge of the systematic part of the generating process for earnings changes, the below regression will yield coefficients of values $\alpha = 0$ and $\beta = 1$.

$$A_i = \alpha + \beta P_i + \epsilon_i \quad \dots 4.19$$

Where A_i = the i th realised change .

P_i = the prediction of the i th change.

α and β = regression coefficients.

ϵ_i = a disturbance, with $E(\epsilon_i) = 0$ for all i .

The mean square error (MSE) is decomposed into three componenets.

Mean Square Error	=	Bias Component	+	Regression Component	+	Disturbance Component	
$1/n \sum (P_i - A_i)^2 = (\bar{P} - \bar{A})^2 + (s_P - r s_A)^2 + (1 + r^2) s_A^2 \quad \dots 4.20$							

Where \bar{P} and \bar{A} are the means.

s_P and s_A are the standard deviations.

and r is the correlation of the predicted and realised changes.

The bias, regression and disturbance components can be shown as a proportion of the MSE, producing the inequality coefficients U^M , U^R and U^D respectively.

$$U^M + U^R + U^D = 1 \quad \dots 4.21$$

The proportion U^M shows the percentage of the total MSE due to error in central tendency (i.e. the bias of the forecast) and is called the bias proportion.

$$U^M = \frac{(\bar{P} - \bar{A})^2}{1/n \sum (P_i - A_i)^2} \quad \dots 4.22$$

The second proportion, U^R , measures the proportion of the MSE due to the deviation of the coefficient β from the 'perfect prediction' value of 1. This is called the regression proportion. The disturbance proportion, U^D , shows the proportion of the MSE that is due to the variance of the regression disturbances.

Efficient forecasts reflect all available information. One source of information available to a forecaster is the series of previous forecast errors.

A forecast (P_{t+1}) made at time t , summed with the eventual forecast error (U_{t+1}), is equal to the realisation (A_{t+1}). Hence;

$$U_{t+1} = A_{t+1} - \hat{A}_{t+1} \quad \dots 4.23$$

The variance bounds test (see Shiller, 1981) for forecast efficiency is presented below.

The forecast error should not be correlated with the forecast, as this would imply that the forecasts could be improved. Hence, for an optimal forecast,

$$\text{cov}(\hat{A}_{t+1}, U_{t+1}) = 0 \quad \dots 4.24$$

The variance of the sum of two uncorrelated variables is the sum of the variances, then it can be written that, from 4.23, for an optimal forecast;

$$\text{var}(A_{t+1}) = \text{var}(\hat{A}_{t+1}) + \text{var}(U_{t+1}) \quad \dots 4.25$$

As variances only take values greater than or equal to zero, then one of the properties of an optimal forecast is that,

$$\text{var}(\hat{A}_{t+1}) < \text{var}(A_{t+1}) \quad \dots 4.26$$

The above inequality may be studied by comparing the variance of a series of forecasts with the variance of a series of the realisations.

The variance of a set of forecasts or realisations of a variable x , denoted $V(x)$, is given by the equation below.

$$V(x) = \frac{\sum (x_i - \bar{x})^2}{n - 1} \quad \dots 4.27$$

Where x_i = i th observation (where $i = 1, 2, \dots, n$)

\bar{x} = mean of observations x_i (where $i = 1, 2, \dots, n$)

As a time-series of earnings may be non-stationary (which would mean that the mean value required for calculating the variance would not be constant) it may be better to use a series of earnings forecast changes and realised changes.

THE TIME PROFILE OF ANALYSTS' FORECASTS.

Using the methods described above for evaluating forecast accuracy and properties of the forecast distribution (bias and variance), it is possible to create a time profile of these properties, showing how they change over time.

Since chapter 3 indicates that information in analysts' earnings forecasts becomes incorporated into stock-prices, the time profile of analysts' forecast errors may provide an illustration of the impounding process for stock-prices. By investigating bias in the forecast distribution, and how the variance of the distribution changes over time, forecast rationality may be evaluated.

Empirical evidence relating to forecast accuracy and forecast rationality is presented in chapter 5. Evidence is presented on: the accuracy of analysts' earnings forecasts; the time profile of analysts' forecast errors (relating to the impounding process), and both forecast bias and the time profile of the variance of the forecast distribution (relating to forecast rationality).

CHAPTER 5.

ANALYSTS' EARNINGS FORECASTS: A REVIEW OF THE EMPIRICAL EVIDENCE.

OBJECTIVE.

This chapter presents empirical evidence relating to the properties of forecasts discussed in chapter 4. The first section of this chapter presents evidence on the accuracy of analysts' earnings forecasts compared to forecasts from management, or generated by statistical models. The second section presents evidence on the time profile of analysts' forecast errors (i.e. how accuracy changes over time), which may illustrate the impounding process. The third section presents evidence on bias in the forecast distribution of analysts' forecasts, and the time profile of the variance of this distribution, both of which relate to forecast rationality.

Chapter sections.

The accuracy of analysts' earnings forecasts.

The time profile of analysts' forecast errors.

The rationality of analysts' earnings forecasts.

THE ACCURACY OF ANALYSTS' EARNINGS FORECASTS.

This section provides evidence that analysts' forecasts are superior information sources to forecasts from either mechanical models, or firm management. This may account for the findings presented in chapter 3, indicating that information in analysts' earnings forecasts becomes impounded into stock-prices.

Although early studies by Cragg and Malkiel (1968) and Elton and Gruber (1972) find no superiority of analysts' earnings forecasts, over forecasts from naive models, evidence from later studies overwhelmingly supports the superiority of analysts over mechanical models. This evidence is presented below, from studies by Brown and Rozeff (1978), Collins and Hopwood (1980) and Fried and Givoly (1982). Evidence is also presented for the comparative accuracy of analysts' earnings forecasts and management forecasts. Although Basi, Carey and Twark (1976), Imhoff, Jr. (1978) and Ruland (1978) find little difference in accuracy between the two sources, evidence from McNichols (1989) indicates that analysts' earnings forecasts may incorporate information not incorporated in management forecasts.

Brown and Rozeff (1978).

Brown and Rozeff suggest that analysts' forecasts should be superior to univariate time-series models because analysts can take non-earnings

information into account when generating an earnings forecast. Their findings support this hypothesis.

The study compares forecasts of annual and quarterly earnings-per-share generated by three models (a seasonal sub-martingale, a seasonal martingale, and a Box-Jenkins model) with analysts' forecasts, represented by the Value Line Investment Survey. Accuracy is measured using the absolute proportionate forecast error (equation 5.1).

$$|P_{i,j,t} - A_{i,t}| / |A_{i,t}| \quad \dots 5.1$$

Where $P_{i,j,t}$ = predicted earnings for firm i , using forecast source j , for quarter or year t .

$A_{i,t}$ = actual earnings for firm i in quarter or year t .

For each year, or quarter, the absolute proportionate forecast errors from each of the four forecast sources, are compared pair-wise using the Wilcoxon Signed Ranks test. The Wilcoxon test investigates if the median error difference of two forecast sources being compared, exceeds zero. For both annual and quarterly forecasts, analysts' outpredict all three models, with most differences being significant at probability levels of 0.05 or less. Brown and Rozeff (1978) conclude that: "...quarterly and annual comparisons provide convincing evidence .. of Value Line's [i.e. analysts'] superiority over each of the three time-series models.." (p.11).

Collins and Hopwood (1980).

This study provides evidence of the superiority of analysts' forecasts over model forecasts, comparing Value Line forecasts of quarterly earnings to forecasts generated by Box-Jenkins models. Averaging across all firms and years, they find that the mean absolute percentage error for the Value Line forecasts is 10%, while the mean absolute percentage error for the best Box-Jenkins model is 15%.

Fried and Givoly (1982).

Fried and Givoly (1982) compare analysts' annual earnings forecasts from the "Earnings Forecaster", with forecasts generated by a time-series model, and an index model (see equations 2.6 and 2.7 in chapter 2). Averaged across all firm-years, analysts outpredict both models, generating a mean percentage absolute error of 16.4%, compared with 19.3% for the time-series model and 20.3% for the index model.

Partial correlation coefficients are then calculated between the two models' forecasts and actual earnings, given analysts' forecasts, and between analysts' forecasts and actual earnings, given the models' forecasts. While partial correlation coefficients for the time-series and cross-section models average -0.04 and 0.01, respectively, the average partial correlation coefficient between analysts' forecasts and actual earnings is 0.51. This suggests that analysts use a considerable amount of information not contained in time-series or cross-sectional properties of earnings.

Studies such as Brown and Rozeff (1978), Collins and Hopwood (1980) and Fried and Givoly (1982) provide evidence for the superiority of analysts' forecasts over forecasts generated by models. However, it may be expected that of all earnings forecast sources, firms' managers would produce the most accurate forecasts, since they have access to 'inside' information about firms which is unavailable to other forecasters. However, Basi, Carey and Twark (1976), Imhoff, Jr. (1978) and Ruland (1978) find no significant difference in forecast accuracy between analysts and management, and McNichols (1989) presents evidence for the superiority of analysts forecasts over management forecasts. These studies are presented below.

Basi, Carey and Twark (1976).

This study finds no significant difference in the accuracy of analysts' forecasts, compared to management forecasts. It compares the accuracy of management forecasts of annual earnings-per-share, collected from "The Wall Street Journal", with analysts' forecasts from the "Earnings Forecaster". The forecasts have all been released during the forecast year, but where two or more forecasts are released, the earliest forecast is used. In order to be sure that analysts' forecasts have not been made with the benefit of any information contained in management forecasts, only analysts' forecasts obtained on the same day as the management forecast release, or earlier, are used. If there are several analyst forecasts, the mean forecast is used. Accuracy is compared

using the absolute, and squared, proportionate forecast errors (see equations 4.10 and 4.11 in chapter 4).

Averaged over all firm-years, Basi, Carey and Twark (1976) find that the mean absolute proportionate forecast error and the mean squared proportionate forecast error are all about 25% less for the management forecasts than for the analysts' forecasts. However, to determine if this difference is significant, Basi, et al. produce cumulative distributions of dollar absolute errors ($|\text{forecast} - \text{actual earnings}|$) and percentage absolute errors ($|\text{forecast} - \text{actual earnings}|/|\text{actual earnings}|$), for both management and analysts. To test if the cumulative distributions are significantly different, the Kolmogorov-Smirnov test is used. Over all firm-years, using the Kolmogorov-Smirnov test, the difference between the distributions is not significant at the probability level 0.05.

Imhoff, Jr. (1978).

Imhoff, Jr. compares the accuracy of analysts' forecasts from the "Earnings Forecaster" with management forecasts from "The Wall Street Journal" and concludes that neither source exhibits significantly superior forecast accuracy. Only forecasts made at least eight months in advance of the year-end are included in this study.

For both analysts' and management forecasts, the relative prediction error (RPE) is calculated;

$$\text{RPE} = \frac{\text{Actual Earnings} - \text{Forecast Earnings}}{\text{Forecast Earnings}} \quad \dots 5.2$$

Across all firm-years, the mean RPE for management is 16.10%, and for analysts it is 16.68%. Using the Kolmogorov-Smirnov (K-S) test for examining the cumulative error distributions of the two forecast sources, no significant difference is found between the RPE and absolute RPE distributions of the two sources, at probability level 0.05. The conclusion that management forecasts and analysts' forecasts are not significantly different gives support to the findings of Basi, Carey and Twark (1976) who arrive at the same conclusion.

Ruland (1978).

Ruland (1978) provides another comparison between management earnings forecasts, taken from the "Wall Street Journal", and analysts' forecasts, from the "Earnings Forecaster", and concludes in that there is no significant difference in accuracy.

Ruland (p.439-441) criticises the criteria of Basi et al.(1976) for the selection of analysts' forecasts. Basi et al. only use analyst forecasts published prior to, or on, the same day that the management forecasts are published, to prevent analysts from incorporating management forecasts into their own forecasts. As a result, analysts' forecasts are compared with management forecasts which had been made over a shorter forecast horizon. Ruland addresses this criticism by presenting results for analysts' forecasts published both before, and after, the publication of management forecasts.

Another criticism by Ruland of the Basi et al.(1976) study is the study's conclusion that management forecasts, and, hence, analyst forecasts, are "relatively poor" (Basi et al. p.253). Ruland points to

the fact that as only two forecast sources are compared it is unreasonable to conclude that both are relatively poor sources for forecasts. Such a conclusion could only be arrived at if many forecast sources are compared. To address this criticism, an extrapolative model (Ruland, p.444) is used to provide a third source of forecasts.

The proportion of occasions when the respective forecast sources are the best, as defined by smallest absolute proportionate forecast error (see equation 4.10 in chapter 4), are calculated for when analyst forecasts are published before management forecast, and for when management forecasts are published before analysts'. The proportions are presented in Table 5.1 below.

Table 5.1: Relative accuracy of annual E.P.S. forecasts by analysts, management and an extrapolative model (with accuracy defined as the smallest absolute proportionate forecast error).

	Management accuracy best	Analysts accuracy best	Naive model best
Analysts published before management.	44 %	31 %	25 %
Management published before analysts.	41 %	35 %	24 %

Source: Ruland, The Accuracy of Forecasts by Management and by Financial Analysts, The Accounting review (April 1978), (p.444).

In order to find if the differences in forecast accuracy are significant, the Wilcoxon matched-pairs signed-ranks test is used. Testing the null-hypothesis of no difference between the expected and observed frequency of superior forecasts of one source over another, it is found that the difference between management and analyst forecasts is not significant at probability level 0.05, either before or after the publishing of management forecasts.

McNichols (1989).

A recent study by McNichols (1989) suggests that analysts' forecasts may be a superior source of earnings information to management forecasts.

Analysts' forecasts of earnings are collected at a time $t = 0$, prior to the publishing of management forecasts of earnings (time $t = 1$). Actual earnings are announced at a time $t = 2$. Firm-years are divided into a 'positive' portfolio, when the management earnings forecast is greater than the median analysts' forecast, and a 'negative' portfolio when the management earnings forecast is less than the median analysts' forecast. Between the times $t=0$ and $t=1$ it is found that cumulative abnormal returns are positive for the 'positive' portfolio, and negative for the 'negative' portfolio. This may indicate that analysts have predicted, and traded upon, information that is eventually incorporated into management forecasts.

Firm-years are then divided into another two portfolios: a 'positive' portfolio, when actual earnings are greater than the management forecast, and a 'negative' portfolio, when actual earnings are less than

the management forecast. It is found that, in the period upto the forecast announcement by management, cumulative abnormal returns are positive for the 'positive' portfolio and negative for the 'negative' portfolio. This indicates that analysts may have, and be trading on, earnings information that management do not have.

The above evidence suggests that analysts incorporate information into earnings forecasts, not incorporated by other forecast sources. This suggests that analysts' earnings forecasts provide a superior source of information for the market than alternative forecast sources, and this may explain the evidence from chapter 3 which indicates that information in analysts' earnings forecasts becomes incorporated into stock-prices.

THE TIME-PROFILE OF ANALYSTS' FORECAST ERRORS.

Evidence is presented below about changes in analysts' forecast errors over time, which may provide an illustration of the impounding process for stock-prices. Studies by Cooper and Taylor (1983), Cooper (1984), Brown, Foster and Noreen (1985), O'Brien (1988) and Patz (1989), are presented below, and all find that accuracy improves over time.

Cooper and Taylor (1983) and Cooper (1984).

These two studies, with identical methodologies, both find that the accuracy of analysts' annual earnings forecasts improves noticeably after

the publishing of interim earnings. The studies use mean analysts' forecasts, calculated from forecasts of several individual analysts, suggesting that "it is likely that ..[investors] .. would seek a range of [earnings] estimates rather than rely only on their own brokers for advice." (Cooper and Taylor, p.15).

The accuracy measure used is the root mean square error, which is calculated from the sample of forecasts for each firm, for forecasts made before the interim announcement, and after. For a sample of n predictions (P) and realisations (A) the RMSE is given by equation 5.3.

$$\text{RMSE} = \sqrt{1/n \sum (P - A)^2} \quad \dots 5.3$$

Results for Cooper and Taylor indicate that across all firms, the average RMSE for forecasts made after the interim announcement is only about 60% of the average RMSE for forecasts made before the interim announcement. Similar results are found by Cooper.

Brown, Foster and Noreen (1985).

This study investigates the accuracy of consensus analysts' forecasts, defined as the median analyst's forecast, using the absolute forecast error (actual earnings - forecast) and the square of the forecast error, aggregated across all firm-years. The median value of these error metrics, at each monthly forecast horizon from month -22, relative to the announcement month, to month -1, are calculated. For both error metrics, there is an almost uninterrupted and noticeable decrease over time.

O'Brien (1988).

This study finds that analysts' earnings forecasts become more accurate over time, indicating that they incorporate new information. Analysts' forecasts of annual earnings-per-share are obtained for five forecast horizons: 240; 180; 120; 60, and 5 trading days. The study uses three measures of analysts' forecasts: the mean; the median, and the most recent of the analysts' forecasts, available at a given horizon. For all three measures, it is found that the absolute forecast error, averaged across all firm-years, declines as the forecast horizon gets shorter.

Patz (1989).

This study also provides evidence of the improvement in analysts' forecast accuracy, over time. Patz compares the accuracy of 'short-term' analysts' earnings forecasts, made at a forecast horizon of twelve months or less, with 'long-term' forecasts, made at a forecast horizon greater than twelve months. Using the relative prediction error (RPE) used by Imhoff, Jr. (1978) (see above), Patz finds that across all firm-years, 65% of RPE's for short-term forecasts are within the range $\pm 15\%$. However, for long-term forecasts, only 35% of RPE's are within the range $\pm 15\%$.

The findings suggest that information is incorporated into analysts' earnings forecasts, over time, and this process may illustrate the impounding process.

THE RATIONALITY OF ANALYSTS' EARNINGS FORECASTS.

The rationality of analysts' earnings forecasts may be evaluated by investigating the forecast, or forecast error, distribution. Evidence on forecast bias appears to differ between US and UK analysts. Evidence from the US generally suggests either unbiasedness or a tendency to overestimate earnings, while evidence from the UK, although mixed, points towards a tendency to underestimate earnings. Another property of rational analysts' forecasts is that the variance of the forecast distribution decreases over time as new information becomes available. Since the forecast distribution is unknown it must be estimated. This may be done by obtaining a sample of earnings forecasts for a given firm, from different analysts. The distribution of analysts' forecasts at a given horizon, may also be estimated using a distribution of scaled forecast errors, for a sample of firms. Evidence presented below suggests that both forecast variance, and forecast error variation around zero, decline over time, consistent with efficient forecasts. Evidence is first presented on bias in analysts' earnings forecasts, and then on the decline in forecast variance over time.

Evidence presented below indicates a tendency for UK analysts to underestimate earnings, but conclusions of unbiasedness or a tendency to overestimate, for US analysts.

Crichfield, Dyckman and Lakonishok (1978).

This study concludes that US analysts' forecasts are unbiased. It uses US analysts' forecasts of annual earnings-per-share growth, obtained from the "Earnings Forecaster" over the ten year period 1967-1976, to estimate the below regression;

$$A_i = \alpha + \beta P_i + \epsilon_i \quad \dots 5.4$$

Where A_i = i th realised change

P_i = i th predicted change

α and β = regression coefficients

ϵ_i = disturbance (following usual assumptions)

If forecasts are unbiased, the parameters α and β are expected to have the values 0 and 1 respectively. Crichfield, Dyckman and Lakonishok (1978) conclude that α and β are not significantly different from the hypothesised values of 0 and 1 respectively, indicating unbiasedness. Decomposing the mean square error using Theil partial inequality coefficients (see equation 4.20 in Chapter 4), the study concludes that bias only accounts for 18% of the mean square error.

Malkiel and Cragg (1980), and Givoly (1982).

US studies by Malkiel and Cragg (1980), using five-year earnings growth predictions from several analysts, over the years 1961-1969, and Givoly (1982), using the forecasts of 70 analysts, predicting for 400 firms for the 11 years from 1969-1979, arrive at similar conclusions of unbiasedness for analysts' forecasts.

O'Brien (1988).

This study investigates bias in US analysts' earnings forecasts, but concludes in favour of bias towards overestimation. O'Brien suggests that forecast errors, aggregated cross-sectionally over a year t , could indicate bias in forecasts even if the forecasts are completely unbiased. This is because of time-period-specific influences. For example, an unanticipated economic event (i.e. an event which has not been anticipated by the analyst) which has a similar impact on the earnings of all firms in the year t , may result in forecast errors that are cross-sectionally correlated, which may appear to suggest that the forecast source is biased. O'Brien constructs a t -statistic (O'Brien, pp.63-64) to test for bias. O'Brien claims that this t -statistic will eliminate forecast bias that is due to time-period-specific events and so is a measure of bias that is due to the forecast source.

O'Brien finds that analysts' earnings forecasts tend to be significantly biased towards overestimation. However, although O'Brien (p.65) suggests that analysts may deliberately overestimate earnings to maintain good relations with firm management, O'Brien suggests caution

in drawing such a conclusion from these findings, since significant bias, towards overestimation, is also found in Box-Jenkins model forecasts, which are not influenced by concern for relations with management.

De Bondt and Thaler (1990).

This US study adopts a similar approach to Crichfield, Dyckman and Lakonishok (1978), regressing actual changes in earnings on predicted changes (see equation 5.4 above). It is found that the intercept term is negative and that the slope coefficient is less than one, indicating that analysts' forecasts tend to be biased towards overestimation.

Bhaskar and Morris (1984).

They investigate UK analysts' earnings forecasts and conclude that these forecasts tend to be biased towards underestimation. Using the relative forecast error (RFE) described below,

$$\text{RFE} = (\text{Forecast} - \text{Actual})/\text{Forecast} \quad \dots 5.5$$

they test the null-hypothesis that the RFE distribution is normal, about a mean of zero, and reject it at the 99.9% confidence interval. They find that the distribution is negatively skewed, indicating a tendency for UK analysts to underestimate earnings.

Patz (1989).

This UK study, investigating the proportion of overestimates-to-underestimates for analysts' earnings forecasts, and the distribution of forecast errors, find a tendency to overestimate. However, Patz (1989) concludes that "the findings are .. consistent with a general inability to forecast a systematic factor affecting [profits].." (p.271) and does not indicate that over a long time period there will be sizable systematic bias in analysts' earnings forecasts.

O'Hanlon and Whiddett (1990).

This study of UK analysts' earnings forecasts finds evidence of a tendency to underestimate earnings. Actual proportionate annual changes in earnings-per-share (AC), and forecast proportionate changes in EPS (FC) for forecasts made at a 7-month horizon, are calculated. The regression 5.6 is then estimated.

$$AC = \alpha + \beta FC + U \quad \dots 5.6$$

Where α, β = model parameters.

U = random disturbance term following usual assumptions.

Under rationality, α and β should be insignificantly different from the hypothesised values of 0 and 1, respectively. However, it is found that although the estimated value of β is insignificantly different from 1,

the estimate of α is positive, indicating a tendency to underestimate actual earnings changes.

The above evidence, although mixed, suggests bias towards underestimation for UK analysts, and a possible bias towards overestimation for US analysts.

Evidence supporting the reduction in the variance of the forecast distribution, over time, is presented below, from US studies by Crichfield, Dyckman and Lakonishok (1978), Elton, Gruber and Gultekin (1982), and Brown, Foster and Noreen (1985). Bhaskar and Morris (1984) find that forecast error variation around zero declines over time. These findings are consistent with rational forecasts.

Crichfield, Dyckman and Lakonishok (1978).

This study concludes, referring to change in the spread of different analysts' forecasts, as the forecast horizon reduces, state that "while there is a tendency for the variation to decline, the decline [over months -13 to -1, relative to the announcement month] is uneven and often shows some increase in the middle month." (p.665).

Elton, Gruber and Gultekin (1982)

This paper finds that "while there is some decline in the average

dispersion as the estimates get closer to the end of the year, it is not uniform. Most of the decrease in dispersion across analysts occurs in the first four months of the year." (p.18).

Bhaskar and Morris (1984).

This study finds evidence that the variation of forecast errors around zero, for a sample of firms, may decline over time.

This study examines the proportion of relative forecast errors, RFE, (see equation 5.5 in this chapter) falling within a range of $\pm 10\%$, at different forecast horizons. It is found that for forecasts made between the 9-12 month forecast horizons, three-fifths of RFE's are within this range. For forecasts made at horizons less than 3 months, the proportion of RFE's within $\pm 10\%$ is four-fifths.

Brown, Foster and Noreen (1985).

This study, investigating mean standard deviations of analysts' forecasts over the months -20 to -1, relative to the announcement month, find a systematic decrease in the standard deviation over time.

The evidence presented above suggests that analysts' earnings forecasts are superior sources of information to forecasts from models or firm management, and this may explain why the market may incorporate information from analysts' forecasts, into stock-prices. Changes in the accuracy of analysts' forecasts, over time, indicate that analysts do

incorporate new information into earnings forecasts. This time profile may illustrate the impounding process occurring in stock-prices.

Although some US studies indicate unbiasedness, investigations of bias do not appear to provide strong support for the rationality of either US or UK analysts' forecasts. Evidence of declining forecast variance for analysts' earnings forecasts are consistent with rational forecasts.

The following chapter introduces the hypotheses to be tested, and the experimental design, of the empirical study of this thesis, which investigates the impounding process and the rationality of analysts' forecasts through the time-profile of analysts' forecasts.

CHAPTER 6.

THE DATA, NULL-HYPOTHESES AND EXPERIMENTAL DESIGN.

OBJECTIVE.

The aims of the empirical study in this thesis are:

- (a) to investigate the impounding process through the time profile of analysts' forecast errors;
- (b) to evaluate forecast rationality through the time profiles of the mean and variance of the forecast error distribution, and
- (c) to examine the size effect on these properties.

This chapter is divided into four main sections.

The first section provides a description of the data sample used for the empirical study in this thesis.

The second section presents the error metric used in the empirical study, and the rationale for its choice.

The third section presents hypotheses to be tested regarding: the time profile of analysts' forecast errors; the moments of the forecast error distribution, and the influence of firm-size on these properties.

The fourth section describes the methodology employed to investigate the time-profile of analysts' earnings forecasts.

Chapter sections.

The data.

Selection of an error metric.

Hypothesis testing.

6.1 Investigating the impounding process, using analysts' forecast errors.

6.2 Investigating forecast rationality, using the moments of the forecast error distribution.

6.3 The size effect.

Experimental design.

6.4 A brief overview of the experimental design.

6.5 Investigating the impounding process.

6.6 Investigating the rationality of analysts' forecasts.

6.7 Investigating the size effect.

6.8 Statistical testing of parameter significance.

THE DATA.

The data sample, supplied by a well known large firm of stock-brokers, consists of forecasts of annual pre-tax profits made at monthly intervals, and the actual earnings, for 294 firm-year combinations (hereafter referred to simply as 'firms'). A list of these firms is provided in the appendix. Forecasts are made from month -23 through to month -1, relative to the announcement month, and announcements are for the years 1986-1989. For 174 firms, net-assets-per-share are also provided, and it is this measure which is used as the size variable.

Although it may be argued that consensus earnings forecasts, from sources like IBES, may be less influenced by individual idiosyncratic error than forecasts from a single stock-broking firm, it should be noted that consensus forecasts often include 'stale' forecasts. O'Brien (1988) finds that the most recent analyst forecast at a given forecast horizon, tends to be more accurate than consensus forecasts. Also, it is not known how stale forecasts included in sources like IBES actually are. If the impounding process is to be investigated through analysts' earnings forecasts, there is logic in using precisely time-dated forecasts from a large firm of stock-brokers.

O'Brien also suggests that time-period-specific influences may result in forecasts from an unbiased source appearing to display bias (see p.71 in chapter 5). However, since this sample includes announcements for four different years, this empirical study may avoid this problem.

SELECTION OF AN ERROR METRIC.

The properties of forecasts may be investigated by analysing the forecast errors. The forecast error, FE_{imt} , for a particular firm i , at forecast month m , for year t , may be defined simply as;

$$FE_{imt} = F_{imt} - A_{it} \quad \dots 6.1$$

Where F_{imt} = forecast earnings for firm i in year t , made at month m .

A_{it} = actual earnings for firm i in year t .

Hence, a positive forecast error indicates an over-estimation of earnings, and a negative forecast error indicates an under-estimation.

The forecast error, FE , varies with the scale of earnings. However, if forecasts for different firms are to be investigated, a scale free error measure is needed. A scale free error metric will allow direct comparison of forecast accuracy between firms with large earnings numbers, and those with small earnings numbers. The distribution of scaled forecast errors for a sample of firms, at a given forecast horizon, may be regarded as having been drawn from a common distribution. The scaling factor chosen for this study is actual earnings (A). The error metric chosen for this study is, therefore, the proportionate forecast error (PFE), described below.

$$PFE_{imt} = \frac{F_{imt} - A_{it}}{A_{it}} \quad \dots 6.2$$

Where $PFE_{i,m,t}$ = proportionate forecast error for firm i , at month m ,
forecasting earnings in year t .

The PFE measure used in this study is exactly the same as that used by Basi, Carey and Twark (1976) and Brown and Rozeff (1978).

Since the error metric (PFE) is scaled, the PFE distribution for a sample of firms, at a given forecast horizon, is used to estimate the analyst forecast distribution.

There are two main reasons for choosing this value as the scaling factor. Firstly, it will result in the forecast error being given as a proportion of actual earnings. The meaning of such a measure is readily understandable.

Secondly, actual earnings provides a scaling factor which remains constant across the 23 months of forecasts for each firm. The use of the forecast as the deflator, as used by Imhoff, Jr. (1978), would result in the forecast error being scaled by a value that may vary over the 23 month forecast period, for each firm.

A second reason for preferring actual earnings to forecast earnings, as the deflator, is given by Patz (1989) stating that "it is... difficult to circumvent the Lorek (1979) argument that the use of forecasted earnings as a .. [deflator].. implies measurement of a firm's ability to achieve a predicted result, rather than a predictor's ability to forecast an outcome." (p.269 footnote 4).

HYPOTHESES TESTING.

This section presents null-hypotheses to be tested, relating to the time profiles of forecast accuracy and the forecast error distribution, and the size-effect.

6.1 Investigating the impounding process, using analysts' forecast errors.

Evidence from chapter 5 suggests that the accuracy of analysts' earnings forecasts improves over time, and it is inferred that this illustrates the impounding process for stock-prices. The empirical study in this thesis seeks to investigate the impounding process by investigating changes in forecast accuracy, as defined by the absolute proportionate forecast error (absolute PFE), over time. If the time profile of analysts' forecast errors illustrates the impounding process, it is expected that forecast errors, on average, will decline over time. The null and alternative hypotheses are presented below.

H_0 : There is no change, across all firms, in the average absolute PFE, over time.

H_1 : There is change, across all firms, in the average absolute PFE, over time.

6.2 Investigating forecast rationality, using the moments of the forecast error distribution.

Evidence on rationality from chapter 5 indicates that although there is evidence of unbiased earnings forecasts for US analysts, UK evidence suggests a tendency to underestimate. Evidence from chapter 5 also indicates that forecast variance, and forecast error variation around zero, decline over time, consistent with rationality. The study in this thesis investigates the first two moments of the proportionate forecast error (PFE) distribution. If forecasts are rational it is expected that the mean of the PFE distribution will be zero (indicating unbiasedness), and that the variance of the distribution will decline over time. Null and alternative hypotheses relating to changes in the PFE distribution over time, are presented below.

H_0 : Forecast bias at a given forecast horizon, as measured by the mean of the PFE distribution, is zero.

H_1 : Forecast bias at a given forecast horizon, as measured by the mean of the PFE distribution, is non-zero.

H_0 : There is no change in the variance of the PFE distribution, over time.

H_1 - There is change in the variance of the PFE distribution, over time.

6.3 The size effect.

This section presents hypotheses relating to the firm size effect on the time profiles of both analysts' forecast errors and the first two moments of the forecast error distribution. The possible influence of firm size on information production and dissemination led Atiase (1980) to develop the differential information hypothesis. The hypothesis states that information production and dissemination are an increasing function of firm size. Evidence for the hypothesis, from Atiase (1985), Bamber (1986) and Freeman (1987), is presented in chapter 3.

Freeman (1987) presents several factors that may result in analysts collecting and producing more information for larger firms. Trading profits from information, assuming the information is costless, will vary in strict proportion to market value. i.e. "knowledge that a large firm's common stock is 'mispriced' by one percent could be used to earn greater profits than information that would generate a one percent adjustment in the market value of a small firm's common equity." (Freeman, p.196)

However, in reality, because many large firms are complex conglomerates, the cost of information searches may be positively related to firm size. "If such complexities increase the cost of analysing financial data, marginal search costs increase as firm size increases.If marginal search costs increase with firm size, but at a lower rate than marginal trading profits, a large firm's securities are less likely to be mispriced than a small firm's." (Freeman, p.197). If analysts collect and produce more information relating to firms with larger market values, it may be assumed that any extra costs of

collecting information for larger firms, are offset by the extra trading profits.

Another important influence of firm size on the information searches undertaken by analysts, is presented by Freeman (p.198): "Grossman and Stiglitz (1976) note that trading by informed investors partially reveals private information and thereby limits the potential profits from knowledge that a particular security is mispriced. ...The smaller the firm and the more thinly traded the stock, the easier the trading by informed investors is spotted; therefore, Atiase (1980) argues that [this fact]...reduces the potential profit from small-firm information more severely than the profit from large-firm information."

Evidence that analysts' production and dissemination of information may be an increasing function of firm size, is presented below.

A summary of the Freeman (1987) paper is given in Chapter 3. Freeman finds that abnormal returns, relating to forthcoming announcement information, occur (begin,end) earlier for larger firms than for smaller firms. This is the timing hypothesis. It is also found that abnormal returns relating to an earnings announcement are larger for smaller firms than for larger firms. This is the magnitude hypothesis.

These findings are consistent with analysts devoting more resources to the production and dissemination of information relating to larger firms. Further evidence of forthcoming-announcement information being impounded earlier in the stock-prices of larger firms, is provided by Collins, Kothari and Rayburn (1987). This study involves the regression of cumulative abnormal returns for the stock of a firm i , over a year t , on the percentage change in earnings-per-share in year $t+1$. This is

done for sets of firms divided into size quintiles, with size defined as market value. For the lowest market value quintile, containing the smallest firms, the adjusted R^2 is only 0.18. For the upper quintile, containing the largest firms, the R^2 value is 0.41. These results indicate that cumulative abnormal returns for year t explain variation in the percentage change in earnings for year $t+1$, to a much greater extent for larger firms.

Collins, et al. then compare forecasts of earnings for year $t+1$, made by a share-price model (using cumulative abnormal returns for year t), a random walk model (using earnings for year t) and a random walk-with-drift model (using earnings from year $t-5$ to year t). The greatest superiority of the price model over the time-series models, is found for the upper quintile, containing the firms with the largest market values. The greatest superiority of the time-series models over the price model, is found for the lowest quintile, containing the firms with the smallest market values.

Collins et al. conclude that "prices of smaller firms [in the current year] capture little information with respect to future earnings beyond that conveyed in the past time series of earnings. However, for the largest firms in our sample, there is rather clear evidence that price changes in the current year do provide information about next year's earnings changes beyond that contained in the time series of earnings."
(p.127)

The above studies investigate information reflected in stock-prices, and conclusions about the influence of firm size on analysts' earnings forecasts are deduced by implication. Stickel (1989) studies analysts' earnings forecasts directly, investigating the influence of firm size on

analysts' revision activity around interim earnings announcements. Stickel hypothesises that the amount of earnings related information available through more timely media (e.g. Wall Street Journal) increases with firm size. "Thus, the relative informativeness of interim earnings announcements, vis-a-vis other firm-specific earnings-related information revealed at other times, should be less for larger firms." (p.279). Using both market value and trading volume of common stock as measures of firm size, Stickel finds that revision activity after an interim earnings announcement is negatively related to firm size.

Stickel concludes that "This supports the hypothesis that earnings announcements are relatively less timely information sources for larger firms." (p.290). The findings suggest that analysts' earnings forecasts may already reflect a greater proportion of the information contained in interim earnings announcements for larger firms, relative to earnings forecasts for smaller firms.

The evidence above indicates that analysts' earnings forecasts for larger firms may incorporate information earlier than forecasts for smaller firms. Hence, in the light of the above empirical evidence, it may be expected that at a given forecast horizon, the average absolute proportionate forecast error will be a decreasing function of firm size. The null and alternative of this hypothesis are presented below.

H_0 : The average absolute PFE, at a given forecast horizon, is not a function of firm size.

H_1 : The average absolute PFE, at a given forecast horizon, is a function of firm size.

In the context of the investigation of the moments of the forecast error (PFE) distribution, in the light of the empirical evidence presented above, it may be expected that the variance of the PFE distribution, is a decreasing function of firm size. There is little theory relating to the influence of firm size on bias. The null and alternative to these hypotheses are presented below.

H_0 - Forecast bias at a given forecast horizon, as measured by the mean of the PFE distribution, is zero for all firm sizes.

H_1 - Forecast bias at a given forecast horizon, as measured by the mean of the PFE distribution, is non-zero for all firm sizes.

H_0 - The variance of the PFE distribution, at a given forecast horizon, is not a function of firm size.

H_1 - The variance of the PFE distribution, at a given forecast horizon, is a function of firm size.

Null-hypotheses relating to the time profile of analysts' earnings forecasts, and the influence of the size effect on this time profile, are tested using the methodology presented below.

EXPERIMENTAL DESIGN.

6.4 Brief over-view of the experimental design.

The impounding process is to be investigated through the time profile of analysts' forecast errors (absolute PFE). The rationality of analysts' earnings forecasts is to be investigated through the time profiles of the mean and variance of the forecast error (PFE) distribution. These profiles are investigated over three forecast periods.

(1) The Overall Forecast Period:- This includes forecasts for all forecast months from month -23, relative to the announcement month, to month -1.

The overall forecast period is decomposed into two sub-periods, to allow a more detailed study of changes in the properties of analysts' forecasts, over time.

(2) Forecast Period 1:- This covers the forecast months from month

measure accuracy is the absolute proportionate forecast error. The absolute PFE is calculated for each of the 23 forecast months, for all firms in the sample.

In order to investigate how accuracy changes over time, a measure of time is needed. For this purpose a time-variable, T, is introduced. T takes discrete values for each of the forecast months.

For the overall forecast period, T takes values from T = 0 to T = 22 (from month -23 to month -1, relative to the announcement month).

For forecast period 1, the time-variable, T, takes values from T = 0 through to T = 11 (month -23 to month -12, relative to the announcement).

For forecast period 2, the time-variable, T, takes values from T = 0 through to T = 10 (month -11 to month -1, relative to the announcement).

Changes in forecast accuracy, over time, may then be investigated by regressing the absolute PFE on T. The below regression is estimated using ordinary least squares (OLS).

$$|PFE_{imt}| = \alpha + \beta T + U_{imt} \quad \text{for all } i, m \text{ and } t \quad \dots\dots 6.3$$

Where PFE_{imt} = proportionate forecast error for firm i, at month m, forecasting earnings in year t.

T = time-variable.

α and β = model parameters.

U_{imt} = random disturbance term following usual assumptions.

$$\text{i.e. } E(U_{imt}) = 0; \quad \text{var}(U_{imt}) = \sigma^2.$$

By setting the value of T at zero for forecasts at the beginning of each of the three forecast periods, the estimate of the intercept term α , provides an estimate of the average absolute PFE at the beginning of each forecast period. The estimate of the slope coefficient β , indicates the average change in absolute PFE, over the forecast period.

For the regression 6.3, adjusted R^2 values are calculated. This value indicates the proportion of absolute PFE variation that is explained by the forecast horizon, as measured by T.

6.6 Investigating the rationality of analysts' forecasts.

This analysis is in two steps. Step 1 investigates changes in the mean of the PFE distribution, over time, and investigates forecast bias. Step 2 investigates changes in the variance of the PFE distribution, over time, and investigates efficiency.

Step 1.

Step 1 is concerned with investigating changes in the mean of the PFE distribution, over time. This is done by estimating the below regression using ordinary least squares (OLS);

$$PFE_{imt} = \alpha + \beta T + U_{imt} \quad \text{for all } i, m \text{ and } t \quad \dots 6.4$$

Definitions - as for regression 6.3.

The estimate of the intercept term α , is an estimate of the average bias in analysts' forecasts, at the beginning of the forecast period. The estimate of β will indicate whether, on average, forecast bias changes over time.

If analysts' earnings forecasts are rational, it is expected that the estimates of α and β will not be significantly different from zero. However, rationality will also lead to a decrease in the variance of the PFE distribution over time, resulting in a heteroscedastic disturbance term in equation 6.4. The problem of heteroscedasticity for OLS regression is illustrated below.

For the following regression, written in matrix form;

$$y = Xb + e \quad \dots 6.5$$

$$\text{where } E(ee') = W \quad \dots 6.6$$

the OLS estimator of b is;

$$\hat{b} = (X'X)^{-1}X'y \quad \dots 6.7$$

and the estimator of the variance-covariance matrix is;

$$V(\hat{b}) = (X'X)^{-1}X'WX(X'X)^{-1} \quad \dots 6.8$$

If

$$W = \sigma^2 I$$

then

$$V(\hat{b}) = \sigma^2 (X'X)^{-1} \quad \dots 6.9$$

If

$$W \neq \sigma^2 I$$

Although the estimator of b , equation 6.7, remains a linear unbiased estimator, equation 6.9 will provide a biased estimator of the true variance-covariance matrix in 6.8.

White (1980) provides a method for estimating the matrix W , from equation 6.6, when W is non-scalar and unknown, which is used to generate a consistent estimator of $V(\hat{b})$.

The (i,j) th element of the matrix W , w_{ij} , is given by

$$w_{ij} = E(e_i e_j)$$

Although vector e is unknowable, there is an estimator in the OLS residuals, \hat{e} , given by

$$\hat{e} = Y - X\hat{b}$$

Therefore, an obvious possible estimator for w_{ij} is

$$\hat{w}_{ij} = \hat{e}_i \hat{e}_j$$

If errors are heteroscedastic, W is a diagonal matrix, and the White proposal amounts to estimating W by a matrix whose typical diagonal element is \hat{e}_i^2 and whose off-diagonal elements are all zero.

It may then be shown that, defining \hat{W} by

$$\hat{W} = (\hat{w}_{ij})$$

$$\hat{w}_{ij} = \begin{cases} \hat{e}_i^2 & i=j \\ 0 & \text{otherwise} \end{cases}$$

generates a consistent estimator of $V(\hat{b})$ through the use of equation 6.8. Then

$$\hat{V}(\hat{b}) = (X'X)^{-1}X'\hat{W}X(X'X)^{-1}$$

where

$$\hat{V}(\hat{b}) \rightarrow \hat{V}(b)$$

The diagonal elements of $\hat{V}(b)$ then provide estimators of the variances of the coefficient estimators which are robust to heteroscedasticity.

Although the White procedure will provide consistent estimators of the standard errors, it should be noted that the OLS \hat{b} estimators remain inefficient. The White procedure is not a solution to heteroscedasticity in the sense of providing a transformed equation with 'white-noise' disturbances, but it is a useful tool for situations where model transformation may not be a suitable, and it does allow statistical inferences to be drawn. The use of 'White' standard errors to construct t-tests is described in section 6.8.

Step 2.

Step 2 is concerned with investigating changes in the variance of the PFE distribution, over time. As the forecast horizon gets shorter, and more information becomes available to analysts, it is expected that the variance of the PFE distribution around the mean, will decline over time. The change in the variance of the PFE distribution over time is investigated using the Glejser (1969) test for heteroscedasticity. The

absolute values of the residuals from regression 6.4 are regressed on the variable T.

$$|e_{imt}| = \gamma + \delta T + V_{imt} \quad \text{for all } i, m \text{ and } t. \quad \dots 6.11$$

Where e_{imt} = regression residual for firm i , forecast month m ,
announcement year t .

γ and δ = regression parameters.

V_{imt} = random disturbance term following the usual assumptions.

The estimate of the intercept term γ , is a measure of the average variance of the PFE distribution at beginning of the forecast period. It should be noted that γ is not strictly the PFE variance, but is a measure of variation around the regression line. The estimate of the coefficient δ indicates whether this variance around the regression line, changes over time.

6.7 Investigating the size effect.

Hypotheses which relate to the influence of firm size on the time profile of analysts' earnings forecasts are presented in section 6.3. The size effect is investigated by carrying out the above experiments on size-segregated sets of firms, with net-assets-per-share as the size measure. Firms are divided in two ways; into 'below the median' and 'above the median' firms, and into 'lower quartile', 'interquartile range' and 'upper quartile' firms.

6.8 Statistical testing of parameter significance.

Since nothing is known about the properties of the earnings forecasts in the sample, parameter estimates may take either positive or negative values and, therefore, a two-tail t-test is carried out, at a significance level of 0.05, for all regressions. The t-statistic for each parameter estimate, is calculated by dividing the OLS estimate of the parameter by the 'White' standard error.

Chapter 7 presents the results, discusses the findings, and suggests possible shortcomings of this empirical study and further research.

CHAPTER 7.

THE RESULTS, DISCUSSION, AND CONCLUSIONS OF THE EMPIRICAL STUDY.

OBJECTIVE.

The objective of this chapter is:

- (i) to present the results of the empirical study;
- (ii) to discuss the findings in the light of evidence from other accounting studies, and
- (iii) to present shortcomings of the study and suggest further research.

<u>Chapter sections.</u>
Objective.
The results tables
Presentation of the results.
7.1 Investigating the impounding process.
7.2 Investigating the rationality of analysts' forecasts.
7.3 The size effect.
Discussion of the findings.
Conclusion.
Shortcomings of the study and further research.

THE RESULTS TABLES.

The results are presented in Tables 6.1 to 6.6 (each of which has two panels, A and B). Tables 6.1, 6.2 and 6.3 present regression results for the regression of the absolute proportionate forecast error (PFE), on the time variable T, for the overall forecast period, forecast period 1 and forecast period 2, respectively. This regression investigates the time profile of analysts' forecast errors, an investigation that relates to the impounding process.

Tables 6.4, 6.5 and 6.6 present two sets of regression results. One set corresponds to the regression of the PFE on T (investigating the time profile of the mean of the PFE distribution). The second set of results correspond to the regression of the absolute residuals of the PFE v. T regression, denoted $|e|$, on T (investigating the time profile of the variance of the PFE distribution around the regression line). These regressions investigate forecast bias and efficiency, respectively, in order to evaluate forecast rationality.

In constructing the lower quartile, median and upper quartile boundaries, an extra constraint is added. This constraint is that all observations for a particular firm should be in the same firm-size group. As a result the numbers of firms in upper quartiles do differ slightly with the numbers of firms in lower quartiles. Also, observations for firms on the median/quartile boundaries, are eliminated. Hence, the sum of the number of firms in the different size sub-sets is less than the 174 'firms with size'. n.b. "Below/above the median firms" are referred to as simply 'small' and 'large' firms, respectively, for convenience.

TABLE 6.1: THE TIME PROFILE OF ANALYSTS' FORECAST ERRORS.Overall forecast period: $|PFE| = \alpha + \beta T + U$ PANEL A.

	$\hat{\alpha}$	$\hat{\beta}$	\bar{R}^2
All Firms (n = 294 x 23)	0.170* (4.1E-03) [3.2E-03]	-6.3E-03* (2.5E-04) [2.4E-04]	0.0970
All Firms with size (n = 174 x 23)	0.169* (5.2E-03) [4.1E-03]	-6.3E-03* (3.2E-04) [3.1E-04]	0.0990
Small firms (n = 86 x 23)	0.144* (5.6E-03) [4.1E-03]	-5.6E-03* (3.5E-04) [3.1E-04]	0.1540
Large firms (n = 84 x 23)	0.197* (8.7E-03) [7.2E-03]	-7.2E-03* (5.4E-04) [5.5E-04]	0.0853

* denotes that a parameter estimate is significant at probability 0.05 using a two-tail t-test.

n = number of forecasts = number of x number of
in each sample firm-years forecast months

The 'White' estimated standard error is presented (x).

The OLS estimated standard error is presented [x].

TABLE 6.1: THE TIME PROFILE OF ANALYSTS' FORECAST ERRORS.

Overall forecast period: $|PFE| = \alpha + \beta T + U$

PANEL B.

	$\hat{\alpha}$	$\hat{\beta}$	\bar{R}^2
Lower quartile firms (n = 44 x 23)	0.156* (7.8E-03) [5.7E-03]	-6.4E-03* (4.7E-04) [4.2E-04]	0.2054
Interquartile range firms (n = 79 x 23)	0.156* (6.7E-03) [5.4E-03]	-5.8E-03* (4.1E-04) [4.1E-04]	0.0984
Upper quartile firms (n = 42 x 23)	0.205* (0.013) [0.011]	-7.2E-03* (8.5E-04) [8.3E-04]	0.0758

* denotes that a parameter estimate is significant at probability 0.05 using a two-tail t-test.

n = number of forecasts in each sample = number of firm-years x number of forecast months

The 'White' estimated standard error is presented (x).
The OLS estimated standard error is presented [x].



TABLE 6.2: THE TIME PROFILE OF ANALYSTS' FORECAST ERRORS.

Forecast period 1: $|PFE| = \alpha + \beta T + U$

PANEL A.

	$\hat{\alpha}$	$\hat{\beta}$	\bar{R}^2
All Firms (n = 294 x 12)	0.164* (6.1E-03) [5.8E-03]	-5.2E-03* (8.2E-04) [8.6E-04]	0.0118
All Firms with size (n = 174 x 12)	0.160* (7.8E-03) [7.3E-03]	-4.6E-03* (1.1E-03) [1.1E-03]	0.0093
Small firms (n = 86 x 12)	0.147* (8.7E-03) [7.5E-03]	-6.0E-03* (1.2E-03) [1.1E-03]	0.0311
Large firms (n = 84 x 12)	0.177* (0.013) [0.012]	-3.3E-03* (1.8E-03) [1.8E-03]	0.0025

* denotes that a parameter estimate is significant at probability 0.05 using a two-tail t-test.

n = number of forecasts = number of x number of
in each sample firm-years forecast months

The 'White' estimated standard error is presented (x).

The OLS estimated standard error is presented [x].

TABLE 6.2: THE TIME PROFILE OF ANALYSTS' FORECAST ERRORS.

Forecast period 1: $|PFE| = \alpha + \beta T + U$ -----
PANEL B.

	$\hat{\alpha}$	$\hat{\beta}$	\bar{R}^2
Lower quartile firms (n = 44 x 12)	0.158* (0.012) [0.011]	-6.6E-03* (1.6E-03) [1.6E-03]	0.0383
Interquartile range firms (n = 79 x 12)	0.149* (9.5E-03) [9.7E-03]	-4.5E-03* (1.4E-03) [1.4E-03]	0.0095
Upper quartile firms (n = 42 x 12)	0.176* (0.021) [0.018]	-2.4E-03 (2.8E-03) [2.7E-03]	-0.0005

* denotes that a parameter estimate is significant at probability 0.05 using a two-tail t-test.

n = number of forecasts = number of x number of
in each sample firm-years forecast months

The 'White' estimated standard error is presented (x).

The OLS estimated standard error is presented [x].

TABLE 6.3: THE TIME PROFILE OF ANALYSTS' FORECAST ERRORS.

Forecast period 2: $|PFE| = \alpha + \beta T + U$

PANEL A.

	$\hat{\alpha}$	$\hat{\beta}$	\bar{R}^2
All Firms (n = 294 x 11)	0.094* (3.2E-03) [2.6E-03]	-6.6E-03* (4.5E-04) [4.4E-04]	0.0645
All Firms with size (n = 174 x 11)	0.096* (4.3E-03) [3.6E-03]	-7.0E-03* (6.0E-04) [6.0E-04]	0.0667
Small firms (n = 86 x 11)	0.072* (3.8E-03) [3.1E-03]	-4.7E-03* (5.6E-04) [5.2E-04]	0.0829
Large firms (n = 84 x 11)	0.120* (7.8E-03) [6.4E-03]	-9.3E-03* (1.1E-03) [1.1E-03]	0.0723

* denotes that a parameter estimate is significant at probability 0.05 using a two-tail t-test.

n = number of forecasts = number of x number of
in each sample firm-years forecast months

The 'White' estimated standard error is presented (x).
The OLS estimated standard error is presented [x].

TABLE 6.3: THE TIME PROFILE OF ANALYSTS' FORECAST ERRORS.

Forecast period 2: $|PFE| = \alpha + \beta T + U$ -----
PANEL B.

	$\hat{\alpha}$	$\hat{\beta}$	\bar{R}^2
Lower quartile	0.071*	-5.1E-03*	0.1195
firms	(5.2E-03)	(7.3E-04)	
(n = 44 x 11)	[3.8E-03]	[6.4E-04]	
Interquartile range	0.082*	-5.4E-03*	0.0603
firms	(4.7E-03)	(7.0E-04)	
(n = 79 x 11)	[4.1E-03]	[6.9E-04]	
Upper quartile	0.148*	-0.013*	0.0955
firms	(0.013)	(1.8E-03)	
(n = 42 x 11)	[0.011]	[1.8E-03]	

* denotes that a parameter estimate is significant at probability 0.05 using a two-tail t-test.

n = number of forecasts = number of x number of
in each sample firm-years forecast months

The 'White' estimated standard error is presented (x).

The OLS estimated standard error is presented [x].

TABLE 6.4: THE TIME PROFILE OF FORECAST ERROR (PFE) DISTRIBUTION.

Overall forecast period: $PFE = \alpha + \beta T + U$ (mean of PFE).
 $|e| = \gamma + \delta T + V$ (variance of PFE).

PANEL A.

	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\gamma}$	$\hat{\delta}$
All Firms (n = 294 x 23)	-0.050* (5.3E-03) [4.2E-03]	1.8E-03* (3.3E-04) [3.1E-04]	0.157* (4.2E-03) [3.3E-03]	-5.8E-03* (2.6E-04) [2.5E-04]
All Firms with size (n = 174 x 23)	-0.064* (6.6E-03) [5.3E-03]	2.7E-03* (4.1E-04) [4.0E-04]	0.153* (5.2E-03) [4.2E-03]	-5.6E-03* (3.2E-04) [3.2E-04]
Small firms (n = 86 x 23)	-0.096* (7.1E-03) [5.2E-03]	4.0E-03* (4.4E-04) [3.9E-04]	0.128* (4.8E-03) [3.6E-03]	-4.9E-03* (3.0E-04) [2.7E-04]
Large firms (n = 84 x 23)	-0.035* (0.011) [9.3E-03]	1.5E-03* (7.0E-04) [7.0E-04]	0.186* (9.0E-03) [7.4E-03]	-6.6E-03* (5.5E-04) [5.6E-04]

* denotes that a parameter estimate is significant at probability 0.05 using a two-tail t-test.

n = number of forecasts = number of x number of
in each sample firm-years forecast months

The 'White' estimated standard error is presented (x).

The OLS estimated standard error is presented [x].

TABLE 6.4: THE TIME PROFILE OF THE FORECAST ERROR (PFE) DISTRIBUTION.

Overall forecast period: $PFE = \alpha + \beta T + U$ (mean of PFE).
 $|e| = \gamma + \delta T + V$ (variance of PFE).

PANEL B.

	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\gamma}$	$\hat{\delta}$
Lower quartile	-0.119*	5.0E-03*	0.135*	-5.6E-03*
firms	(9.7E-03)	(5.9E-04)	(5.9E-03)	(3.6E-04)
(n = 44 x 23)	[7.0E-03]	[5.2E-04]	[4.4E-03]	[3.3E-04]
Interquartile range	-0.057*	2.3E-03*	0.140*	-5.2E-03*
firms	(8.7E-03)	(5.3E-04)	(6.7E-03)	(4.1E-04)
(n = 79 x 23)	[6.9E-03]	[5.3E-04]	[5.5E-03]	[4.2E-04]
Upper quartile	-0.011	7.1E-04	0.202*	-7.0E-03*
firms	(0.017)	(1.1E-03)	(0.014)	(8.5E-04)
(n = 42 x 23)	[0.014]	[1.1E-03]	[0.011]	[8.4E-04]

* denotes that a parameter estimate is significant at probability 0.05 using a two-tail t-test.

n = number of forecasts = number of x number of
in each sample firm-years forecast months

The 'White' estimated standard error is presented (x).

The OLS estimated standard error is presented [x].

TABLE 6.5: THE TIME PROFILE OF THE FORECAST ERROR (PFE) DISTRIBUTION.Forecast period 1: $PFE = \alpha + \beta T + U$ (mean of PFE). $|e| = \gamma + \delta T + V$ (variance of PFE).PANEL A.

	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\gamma}$	$\hat{\delta}$
All Firms (n = 294 x 12)	-0.053* (8.0E-03) [7.5E-03]	2.2E-03* (1.1E-03) [1.1E-03]	0.151* (6.2E-03) [5.9E-03]	-4.7E-03* (8.3E-04) [8.7E-04]
All Firms with size (n = 174 x 12)	-0.067* (0.010) [9.3E-03]	2.9E-03* (1.4E-03) [1.4E-03]	0.144* (7.8E-03) [7.4E-03]	-4.1E-03* (1.1E-03) [1.1E-03]
Small firms (n = 86 x 12)	-0.097* (0.011) [9.5E-03]	3.7E-03* (1.5E-03) [1.4E-03]	0.133* (7.4E-03) [6.5E-03]	-5.9E-03* (9.8E-04) [9.5E-04]
Large firms (n = 84 x 12)	-0.041* (0.017) [0.016]	2.3E-03 (2.4E-03) [2.4E-03]	0.164* (0.013) [0.013]	-2.7E-03 (1.9E-03) [1.9E-03]

* denotes that a parameter estimate is significant at probability 0.05 using a two-tail t-test.

n = number of forecasts = number of x number of
in each sample firm-years forecast months

The 'White' estimated standard error is presented (x).

The OLS estimated standard error is presented [x].

TABLE 6.5: THE TIME PROFILE OF THE FORECAST ERROR (PFE) DISTRIBUTION.Forecast period 1: $PFE = \alpha + \beta T + U$ (mean of PFE). $|e| = \gamma + \delta T + V$ (variance of PFE).PANEL B.

	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\gamma}$	$\hat{\delta}$
Lower quartile	-0.117*	4.2E-03*	0.140*	-6.3E-03*
firms	(0.015)	(2.0E-03)	(9.4E-03)	(1.3E-03)
(n = 44 x 12)	[0.013]	[1.9E-03]	[8.1E-03]	[1.2E-03]
Interquartile range	-0.060*	2.7E-03	0.137*	-4.4E-03*
firms	(0.013)	(1.8E-03)	(9.5E-03)	(1.4E-03)
(n = 79 x 12)	[0.012]	[1.8E-03]	[9.9E-03]	[1.5E-03]
Upper quartile	-0.019	1.4E-03	0.172*	-2.1E-03
firms	(0.027)	(3.7E-03)	(0.021)	(2.9E-03)
(n = 42 x 12)	[0.024]	[3.6E-03]	[0.019]	[2.7E-03]

* denotes that a parameter estimate is significant at probability 0.05 using a two-tail t-test.

n = number of forecasts = number of x number of
in each sample firm-years forecast months

The 'White' estimated standard error is presented (x).

The OLS estimated standard error is presented [x].

TABLE 6.6: THE TIME PROFILE OF THE FORECAST ERROR (PFE) DISTRIBUTION.

Forecast period 2: $PFE = \alpha + \beta T + U$ (mean of PFE).

$|e| = \gamma + \delta T + V$ (variance of PFE).

PANEL A.

	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\gamma}$	$\hat{\delta}$
All Firms (n = 294 x 11)	-0.017* (4.2E-03) [3.4E-03]	-1.1E-04 (5.8E-04) [5.6E-04]	0.091* (3.3E-03) [2.6E-03]	-6.6E-03* (4.5E-04) [4.5E-04]
All Firms with size (n = 174 x 11)	-0.019* (5.6E-03) [4.5E-03]	4.6E-04 (7.6E-04) [7.5E-04]	0.092* (4.4E-03) [3.6E-03]	-6.9E-03* (6.0E-04) [6.1E-04]
Small firms (n = 86 x 11)	-0.034* (5.1E-03) [4.1E-03]	1.7E-03* (7.3E-04) [6.9E-04]	0.067* (3.5E-03) [2.9E-03]	-4.5E-03* (5.1E-04) [4.8E-04]
Large firms (n = 84 x 11)	-2.8E-03 (0.010) [8.1E-03]	-8.8E-04 (1.4E-03) [1.4E-03]	0.120* (7.8E-03) [6.5E-03]	-9.6E-03* (1.1E-03) [1.1E-03]

* denotes that a parameter estimate is significant at probability 0.05 using a two-tail t-test.

n = number of forecasts = number of x number of
in each sample firm-years forecast months

The 'White' estimated standard error is presented (x).

The OLS estimated standard error is presented [x].

TABLE 6.6: THE TIME PROFILE OF THE FORECAST ERROR (PFE) DISTRIBUTION.Forecast period 2: $PFE = \alpha + \beta T + U$ (mean of PFE). $|e| = \gamma + \delta T + V$ (variance of PFE).PANEL B.

	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\gamma}$	$\hat{\delta}$
Lower quartile	-0.048*	3.3E-03*	0.062*	-4.5E-03*
firms	(6.6E-03)	(9.2E-04)	(4.4E-03)	(6.2E-04)
(n = 44 x 11)	[4.9E-03]	[8.2E-04]	[3.2E-03]	[5.4E-04]
Interquartile range	-0.023*	1.2E-03	0.078*	-5.2E-03*
firms	(6.4E-03)	(9.1E-04)	(4.8E-03)	(7.1E-04)
(n = 79 x 11)	[5.3E-03]	[9.0E-04]	[4.2E-03]	[7.0E-04]
Upper quartile	0.027	-4.3E-03	0.154*	-0.014*
firms	(0.017)	(2.3E-03)	(0.013)	(1.7E-03)
(n = 42 x 11)	[0.014]	[2.3E-03]	[0.011]	[1.8E-03]

* denotes that a parameter estimate is significant at probability 0.05 using a two-tail t-test.

n = number of forecasts = number of x number of
in each sample firm-years forecast months

The 'White' estimated standard error is presented (x).

The OLS estimated standard error is presented [x].

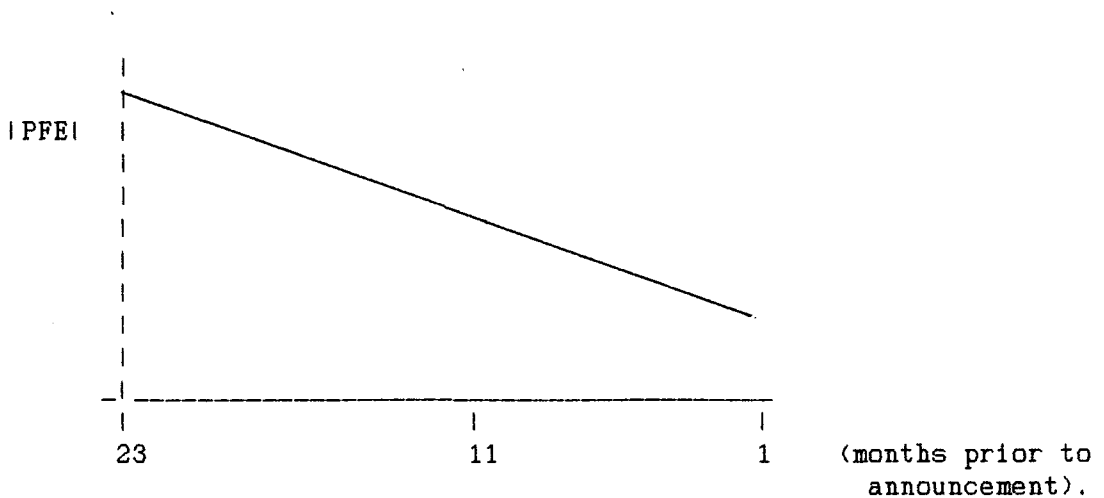
PRESENTATION OF THE RESULTS.

7.1 Investigating the impounding process. (The time profile of analysts' forecast errors).

From Table 6.1 (panel A) the parameter estimate of β for the overall forecast period indicates that, for the 'all firms' sample, the absolute PFE declines over time. The estimates of β for the 'all firms' sample for forecast period 1 (Table 6.2, panel A) and forecast period 2 (Table 6.3, panel A) indicate that the decline over the months -23 to -12 (announcement month = 0) is similar to the decline over the months -11 to -1.

The results indicate a steady systematic improvement in forecast accuracy, and reduction in absolute PFE, over time, as shown by graph 7.1.

Graph 7.1: The time profile of the average absolute PFE, across all firms.



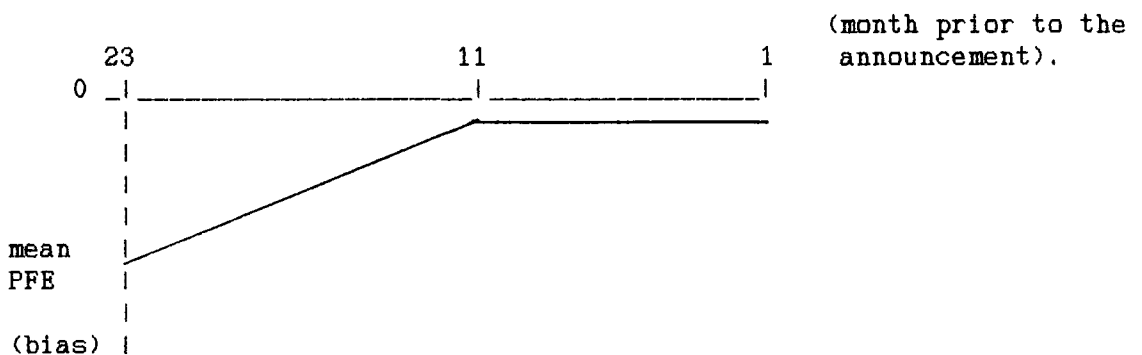
7.2 Investigating the rationality of analysts' forecasts.
(The time profile of the forecast error (PFE) distribution.)

Results are presented for steps 1 and 2 (see equations 6.4 and 6.11, respectively, in chapter 6).

Step 1.

The estimates of α and β for the 'all firms' sample (Table 6.4, panel A) show that the mean of the PFE distribution is -0.05 at the 23-month forecast horizon, indicating a bias in analysts' earnings forecasts towards under-estimation of 5%, and that this bias declines over time. From estimates of β for the 'all firms' sample, for forecast period 1 (Table 6.5, panel A) and forecast period 2 (Table 6.6, panel A) it is found that all the decline in forecast bias occurs between month -23, relative to the announcement month, to month -12. The mean of the PFE distribution from month -11 is estimated to be -0.017, indicating bias towards under-estimation of only 1.7%, and this bias appears to remain through to month -1. The process is illustrated by graph 7.2.

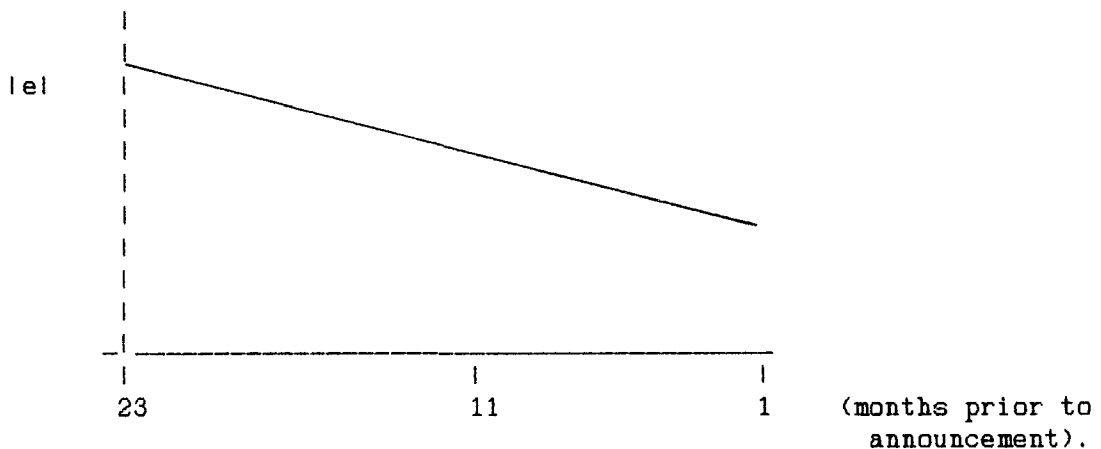
Graph 7.2: The time profile of the mean of the PFE distribution.



Step 2.

The variance of the PFE distribution is investigated via the average absolute residuals from the regression of PFE on T . The estimate of δ for all firms, for the overall forecast period (Table 6.4, panel A), shows that the variance of the PFE distribution around the regression line, declines over time. The estimates of δ for forecast period 1 (Table 6.5, panel A) and forecast period 2 (Table 6.6, panel A) show that this decline is quite evenly divided between these two sub-periods. The average decline in the variance of the PFE distribution, over time, is shown by graph 7.3.

Graph 7.3: The time profile of the variance of the PFE distribution around the regression line, across all firms.



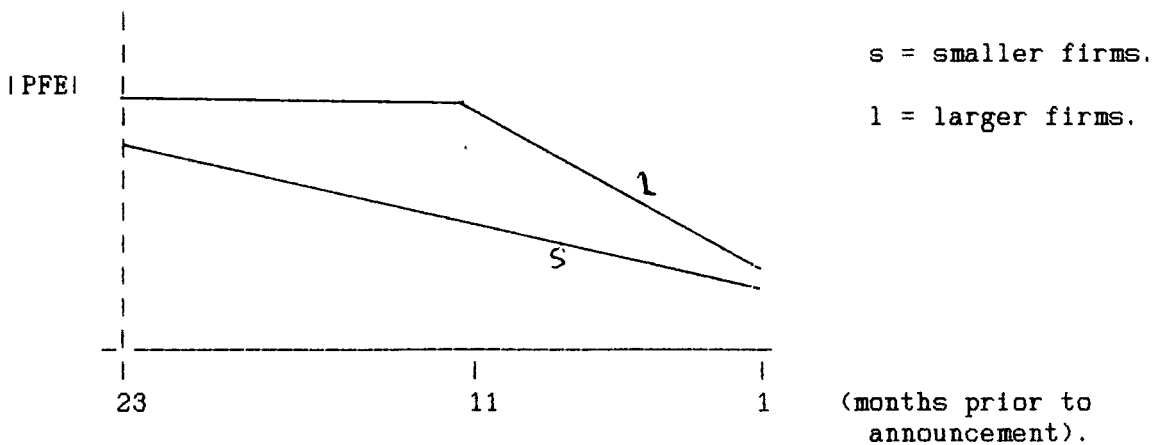
7.3 The size effect.

The size effect is investigated with respect to the impounding process, and forecast rationality.

(i) Impounding process.

The influence of firm size on the time profile of the average absolute PFE is examined by comparing parameter estimates of α and β for 'below the median' and 'lower quartile' firms with those for 'above the median' and 'upper quartile' firms (see Tables 6.1 - 6.3). The results suggest that at the 23 month forecast horizon, the average absolute PFE appears to be positively related to firm size. Estimates of β in Table 6.2 suggest that while the absolute PFE for smaller firms declines steadily over time, the absolute PFE for larger firms declines little from month -23 to month -12, but declines substantially from month -11 to month -1. Graph 7.4 provides a general illustration of this process. It may be noted that adjusted R-square value for the regression of the absolute PFE on the time variable T, is negatively related to firm size (see Table 6.1).

Graph 7.4: The size effect on the time profile of the average absolute PFE.

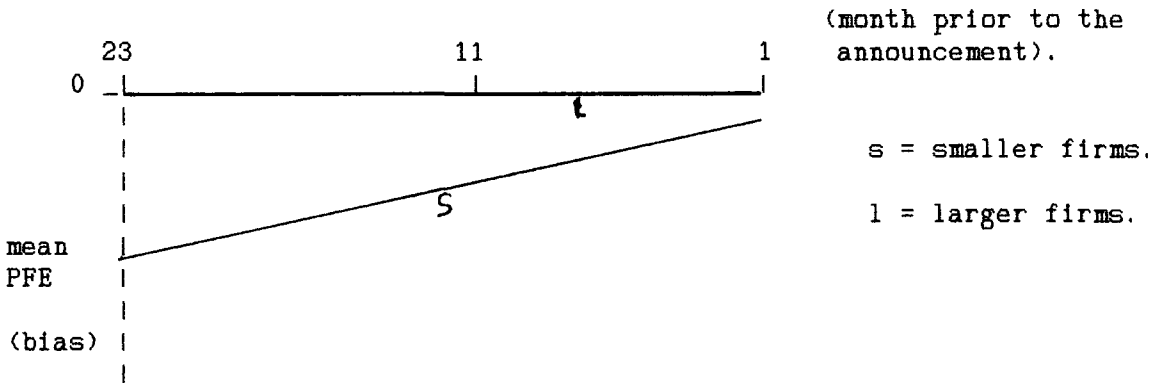


(ii) Forecast rationality.

The influence of the size effect on the time profile of the PFE distribution may be investigated by comparing parameter estimates of α and β (which relate to the mean of the PFE distribution), and γ and δ (which relate to the variance of the PFE distribution around the regression line), for larger and smaller firms (see Tables 6.4 - 6.6).

Parameter estimates of α indicate that bias at both the 23 month (Table 6.4) and 11 month (Table 6.6) horizons, is negatively related to firm size. Forecasts for 'upper quartile' and 'above the median' firms are unbiased at the 23 month, and 11 month, forecast horizons respectively. For smaller firms bias declines over time. A general representation of these results is shown by graph 7.5.

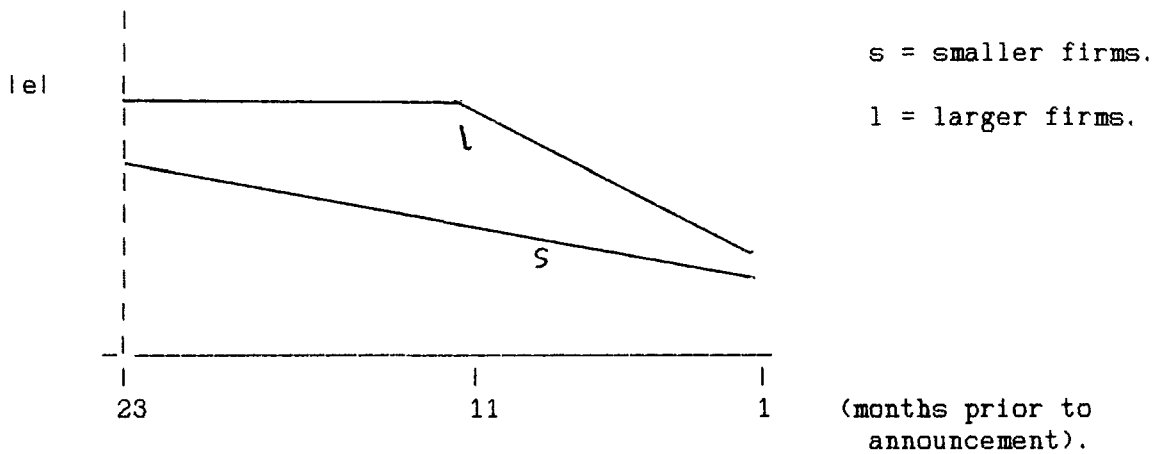
Graph 7.5: The size effect on the time profile of the mean of the PFE distribution.



Parameter estimates of γ indicate that at the 23 month (Table 6.4), and 11 month (table 6.6), forecast horizons the variance of the PFE

distribution around the regression line, is positively related to firm size. Although estimates of δ (Tables 6.5 and 6.6) indicate that PFE variance around the regression line, for smaller firms, declines steadily over time, it is found that for larger firms, PFE variance around the regression line remains unchanged from month -23 to month -12 (announcement = month 0) but declines rapidly from month -11. Graph 7.6 illustrates these findings.

Graph 7.6: The size effect on the time profile of the variance of the PFE distribution around the regression line.



DISCUSSION OF THE FINDINGS.

The discussion relates to the impounding process, forecast rationality and the size effect.

(1) The impounding process.

The time profile of analysts' forecast errors, for the sample of 'all firms', shows a systematic decline over time, illustrating the impounding process. This is consistent with evidence from Cooper and Taylor (1983), Cooper (1984), Brown, Foster and Noreen (1985), O'Brien (1988) and Patz (1989).

(2) Forecast rationality.

The time profile of the moments of the PFE distribution indicate a general tendency for UK analysts to under-estimate earnings. Other evidence of this property of UK analysts is provided by Bhaskar and Morris (1984) and O'Hanlon and Whiddett (1990). Another UK study, by Patz (1989) is inconclusive, finding over-estimation in one year and under-estimation in the next. Bias is inconsistent with rational forecasts. UK evidence contrasts with US research, presented in Chapters 5 and 6, indicating either unbiasedness or a tendency to overestimate earnings.

This study finds that variance of the PFE distribution around the regression line, declines systematically over time, consistent with forecast efficiency and rationality. The results appear consistent with studies by Crichfield, Dyckman and Lakonishok (1978), Elton, Gruber and Gultekin (1982) and Brown, Foster and Noreen (1985) which find that the variance of forecasts around the mean, declines over time.

(3) The size effect.

With reference to the size effect, the findings do not support the pre-test expectation, based on US research, that information is impounded

earlier for larger firms than for smaller firms. The time profile of analysts' forecast errors, as measured by the absolute PFE, indicates that forecast errors are positively related to firm size, and that forecast errors for smaller firms begin to decline much earlier than forecast errors for larger firms. This finding is consistent with the UK study by Bhaskar and Morris (1984) who conclude that "... analysts.. appear to have some difficulty in forecasting the profits of the largest.. companies as accurately as those for [smaller companies]".(p.119). However, a UK study by Patz (1989) finds that "[the] pre-test expectation that accuracy increases with the size of firm was strongly supported," (p.273), although the significance of statistical results supporting this finding appear to differ noticeably between different error metrics.

With reference to the forecast error (PFE) distribution, bias appears to be negatively related to firm size and there is evidence of unbiasedness for the forecasts of larger firms, consistent with forecast rationality. Although the variance of the forecast error (PFE) distribution, declines over time for both larger and smaller firms, it appears to be positively related to firm size and begins to decline much earlier for smaller firms than for larger firms. This finding is consistent with findings by Bhaskar and Morris (1984) who find that the variation of forecast errors around zero is greatest for the largest firms.

Possible explanations for the findings of the empirical study in this thesis, are provided below. Explanations are provided for bias; the

size effect, with respect to the impounding process (investigated via forecast accuracy), and forecast rationality (investigated via the forecast error distribution).

(i) Bias.

With reference to the finding of a general tendency for UK analysts to underestimate, an explanation for UK pessimism, and the contrast with US optimism, is given by O'Hanlon and Whiddett (1990): "[It may be that] the expected positive payoff to being extreme and right [is] greater than the expected negative payoff to being extreme and wrong in the US and [it] is the opposite case in the UK." (p.13).

(ii) The size effect and impounding.

The time profile of analysts' forecast errors indicates that information is not impounded earlier for larger firms than for smaller firms. Indeed the opposite appears to be the case. This contrasts with the findings of US research, presented in section 6.3 of chapter 6.

One possible explanation for this contrast is that accounting standards are more precise in the US than in the UK. Young (Davies, Paterson and Wilson) (1989) find that these differences are greatest with respect to pensions, extraordinary items, and mergers and acquisitions. As a result, US analysts may be able to estimate how a given piece of information will be accounted for with greater accuracy than their UK counterparts. This greater uncertainty for UK analysts may be compounded when estimating earnings for large complex firms, hence, the poorer accuracy for larger firms.

Another explanation for differences between the UK and US with respect to the firm size effect on the impounding process relates to trading profits. It may be that the extra profits from trading on information about larger firms do not compensate for the extra costs of collecting and analysing information about larger, more complex firms, in the UK. In the US, however, such information collection for larger firms may be worthwhile.

A possible explanation for the apparent discrepancy between the findings of Freeman (1987) and this study is that Freeman investigates returns on portfolios of stocks of larger and smaller firms, and not on individual stocks. The creation of a portfolio means that the variances of returns on individual assets may 'cancel out' and the return on a portfolio of assets will usually display less variation than returns on individual assets. As a result, the earnings forecast measure that may be the equivalent to the portfolio returns studied by Freeman, may be the mean PFE, which is the measure used to investigate forecast bias. The findings of the empirical study in this thesis indicate that bias is negatively related to firm size (i.e. larger firms' forecast become unbiased earlier) and this is consistent with the Freeman (1987) findings. It may be that this study, by also investigating forecast error variance, has investigated a factor ignored by the Freeman study because of the 'masking' of individual return variances due to the construction of portfolios.

(iii) The size effect on the forecast error (PFE) distribution.

One explanation for the influence of firm size on the forecast error (PFE) distribution is that, because larger firms tend to be complex

conglomerates, it is difficult for analysts to correctly predict the implications of news for future earnings. News may be misinterpreted, especially when segmental information is poor, leading to either excessive optimism or excessive pessimism. This may lead to greater variance of the forecast error distribution for larger firms, although the mean of the distribution for larger firms may be zero. For less complex smaller firms, the implication of news for future earnings may be more easily assessed, but because of generally less information being available for smaller firms, it may be more difficult to correctly predict earnings on average. This implies that analysts may have to 'stab in the dark', and they may be cautious in doing so. This may result in a forecast error distribution which is biased towards underestimation, but which has a smaller variance than for larger firms.

CONCLUSION.

This study finds little evidence that UK analysts' earnings forecast incorporate announcement information earlier for larger firms than for smaller firms. Indeed, evidence is consistent with the contrary hypothesis.

Evidence is not particularly supportive of the rationality of UK analysts' earnings forecasts across all firms. In general, there appears to be a general tendency towards underestimation which, if accounted for, may allow UK analysts to improve forecasts.

While, there is evidence of unbiasedness for larger firms' earnings forecasts, variance of the error (PFE) distribution is larger for larger firms.

SHORTCOMINGS OF THE STUDY AND FURTHER RESEARCH.

This section presents a number of shortcomings of the empirical study and suggests further research.

1. One reservation regarding the empirical study is the use of net-assets-per-share (NAPS) to define firm size. NAPS is used simply because this is the only relevant value, in the data set provided. However, studies such as Freeman (1987), Collins, Kothari and Rayburn (1987) and Stickel (1989), which present evidence on the influence of firm size, define firm size as the market value of equity. Stickel (1989) also uses the traded volume of common stock, for a given period, as a measure of firm size. The empirical study in this thesis could be replicated using these measures of firm size.

2. Another reservation with respect to the empirical study, is that the sample of earnings forecasts only relate to firms in the FTSE-100, and it may be that all firms are relatively large. Hence, the properties of the samples of smaller firms' forecasts may not really be representative of the properties of forecasts for smaller firms.

3. A third shortcoming of the study is that it only uses one error metric. The error metric used in this study is the proportionate forecast error (PFE);

$$\text{PFE} = \frac{F - A}{A}$$

Where A = actual annual earnings.

F = forecast annual earnings.

The absolute value of the above error metric is used as a measure of accuracy, and is the same accuracy measure used by Basi, Carey and Twark (1976), Brown and Rozeff (1978), Ruland (1978), and Patz (1989). The reasons for using actual earnings as the deflator for the forecast error are given in Chapter 6. Studies by Imhoff, Jr. (1978) and Bhaskar and Morris (1984), however, deflate the forecast error by the earnings forecast, and McNichols (1989) uses a firm's preannouncement share price as the deflator for the forecast error.

The above error metrics correspond to linear loss functions. However, if one assumes that investors' loss functions, with respect to analysts' earnings forecast errors, are quadratic, then this would correspond to a squared-error metric. Examples of these error metrics are the squared proportionate forecast error described in equation 4.11 in chapter 4 and used by Basi, Carey and Twark (1976); the root mean square error used in studies by Cooper and Taylor (1983) and Cooper (1984) (equation 5. in chapter 5); and an error metric used by Patz (1989), consisting

of the squared forecast error deflated by either actual earnings or forecast earnings.

4. If one were to obtain a time-series of forecast and realised earnings changes for individual firms, it would be possible to use Theil (1966) partial inequality coefficients to decompose forecast errors (see Chapter 4). By differentiating firms by size or by industry group, one may conclude the degree to which systematic forecast error may be influenced by these factors. Theil partial inequality coefficients provide an estimate of the proportion of the forecast error that is due to a given factor - something not possible with the methodology of the empirical study.

5. Since the empirical study investigates two aspects of forecast rationality, namely bias and efficiency, a more extensive investigation of rationality may be made by utilising tests presented by Sheffrin (1983) (pp.18-19).

APPENDIX.

All firms (years) for which forecasts are obtained for the empirical study.

ALLIED-LYONS (86, 87, 88, 89)
ARGYLL GROUP (86, 87, 88, 89)
ASDA GROUP (86, 87, 88, 89)
ASSD. BRITISH F (86, 87, 88, 89)
B. A. T. INDUSTRIE (86, 87, 88)
BAA plc (88, 89)
BARCLAYS PLC. (86, 88)
BASS (86, 87, 88)
BET DFD. (86, 87, 88, 89)
BICC (86, 87, 88)
BLUE CIRCLE IND. (86, 87, 88)
BOC GROUP (86, 87, 88)
BOOTS (86, 87, 88, 89)
BP (86, 87, 88)
BPB INDUSTRIES (86, 87, 88, 89)
BRITISH AEROSPA (86, 88)
BRITISH AIRWAYS (87, 88, 89)
BRITISH GAS (87, 88, 89)
BRITISH STEEL (89)
BRITISH TELECOM (86, 87, 88, 89)
BTR (86, 87, 88)
BURMAH OIL (86, 87, 88)
BURTON GROUP (86, 87, 88)
CABEL AND WIRELES (86, 87, 88, 89)
CADBURY SCHWEPP (86, 87, 88)
COMMERCIAL UNIO (86, 87, 88)
COOKSON GROUP (86, 87, 88)
COURTAULDS (86, 87, 88, 89)

ENG. CHINA CLAYS (86, 87, 88)
ENTERPRISE OIL (87, 88)
FISONS (86, 87, 88)
GEC (86, 87, 88, 89)
GENERAL ACCIDEN (86, 87, 88)
GKN (86, 87, 88)
GLAXO HLDGS (86, 87, 88, 89)
GRANADA GROUP (86, 87, 88)
GRAND METROPOLI (86, 87, 88)
GREAT UNIVERSAL (86, 87, 88, 89)
GUARDIAN ROYAL (86, 87, 88,)
GUINNESS (86, 87, 88,)
HAMMERSON PROP. (87, 88,)
HANSON (86, 87, 88,)
HAWKER SIDDELEY (86, 87, 88,)
HILLSDOWN HLDGS (86, 87, 88,)
ICI (86, 87, 88,)
KINGFISHER PLC (86, 87, 88, 89)
LADBROKE (86, 87, 88,)
LAND SECURITIES (86, 87, 88, 89)
LEGAL & GENERAL (86, 87, 88,)
LLOYDS BANK (86, 88,)
LONRHO (86, 87, 88,)
LUCAS INDUSTRIE (86, 87, 88, 89)
MARKS & SPENCER (86, 87, 88, 89)
MEPC (86, 87, 88,)
MIDLAND BANK (86, 88,)
NAT. WEST. BANK (86, 88,)
P&O STEAM NAVIG (88,)
PEARSON (86, 87, 88,)
PILKINGTON (86, 87, 88, 89)
POLLY PECK (86, 87, 88,)
PRUDENTIAL CORP (86, 87, 88,)
RACAL ELECTRONI (86, 87, 88, 89)
RANK ORG. (86, 87, 88,)
RANKS HOVIS (86, 87, 88,)

RECKITT & COLMA (86, 87, 88,)
REDLAND (86, 87, 88,)
REED INTL (87, 88, 89)
REUTERS (86, 87, 88,)
RMC GROUP (86, 87, 88,)
ROLLS-ROYCE (87, 88)
ROTHMANS (86, 87, 88, 89)
ROYAL BK SCOTLA (86, 87, 88,)
ROYAL INSURANCE (86, 87, 88,)
RTZ (86, 87, 88,)
SAINSBURY (J) (86, 87, 88, 89)
SCOT. & NEWCASTL (86, 87, 88, 89)
SEARS (86, 87, 88, 89)
SHELL (86, 87, 88,)
SIEBE (87, 88,)
SMITH & NEPHEW (86, 87, 88,)
STANDARD CHARTE (86, 88,)
STC (86, 87, 88,)
SUN ALLIANCE (86, 87, 88,)
TARMAC (86, 87, 88,)
TAYLOR RODROW (86, 87, 88,)
TESCO STORES (86, 87, 88, 89)
THORN EMI (86, 87, 88, 89)
TRAFALGAR HOUSE (86, 87, 88,)
TRUSTHOUSE FORT (86, 87, 88,)
TSB GROUP (86, 87, 88,)
ULTRAMAR (88,)
UNILEVER (86, 87, 88,)
UNITED BISCUITS (86, 87, 88,)
WELLCOME (86, 87, 88,)
WHITBREAD 'A' (86, 87, 88, 89)

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