Earnings forecasting research: its implications for capital markets research*

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Abstract

Since the early 1980s, earnings forecasting research has become much more closely aligned with capital markets research. Capital markets research requires a proxy for the (unobservable) market earnings expectation and earnings forecasting research has provided such proxy measures. Questions considered in this paper include: (1) if annual earnings follow a random walk or an IMA (1,1) model, does this mean that earnings changes cannot be predicted? (2) Do stock prices act as if quarterly earnings follow a seasonal random walk with drift process? (3) Is the predictive model which is best on the forecast accuracy dimension also best on the market association dimension? (4) How do analysts formulate their earnings expectations? (5) What is the role of earnings forecasting in ‘earnings response coefficient’ and ‘post-earnings announcement drift’ studies? (6) What is the likely role of earnings forecasting research in future capital market studies?

Keywords: Earnings forecasting; Forecast accuracy; Market association; Post earnings announcement drift; Future research

1. Introduction

When Paul Griffin and I issued a call for papers for the “Special Issue on Accounting and Finance” of the Journal of Forecasting [Brown and Griffin (1983)], most of the papers we received were concerned about whether annual earnings follow a random walk (or random walk with drift) process. Nevertheless, this issue was pretty much resolved by the late 1970s. Little (1962) provided evidence that British firms’ annual earnings follow a random walk process and several studies of US firms [Ball and Watts (1972), Albrecht et al. (1977), Watts and Leftwich (1977)] showed that Box-Jenkins (1976) autoregressive integrated moving average (ARIMA) models confined to annual earnings data did not generate more accurate forecasts, in a holdout period, than those based on a random walk model. While the papers published in the special issue did not focus on whether annual earnings follow a random walk (or random walk with drift) process, most did focus on earnings forecasting and lacked implications for capital markets research. A major change in the earnings forecasting literature took place in the 1980s; it became much more closely linked with capital markets research.

Prior to Foster (1977), the earnings forecasting literature focused on predictive ability and evaluated earnings expectation models solely on their ability to forecast future earnings (hereafter, accuracy). Foster introduced an alternative
way to evaluate earnings expectation models, namely contemporaneous market association of abnormal returns with 'earnings surprise', conditional upon the expectation model. (Hereafter, we shall refer to Foster's method as the 'association approach'.) He argued that, given the maintained hypothesis of an efficient market, the strength of association between abnormal returns and earnings surprise indicates how accurately the model captures the market's expectation. Since the capital markets literature requires a proxy for the market's earnings expectation, the association approach made the earnings forecasting literature important for capital markets research, especially when abnormal returns were measured over a narrow window, such as the 2-day period, \((-1, 0)\), where Day 0 is the announcement day [Foster (1977)].

In an informationally efficient market, ignoring transactions costs and costs of generating and processing information, the association and predictive ability approaches should provide similar results. The argument that predictive ability and association are two sides of the same coin is based on the assumption that the capital market uses the best data available, where best is defined as most accurate. This notion is similar to the rational expectations principle which maintains that the subjective probability distribution of outcomes is distributed as the objective probability distribution of outcomes [Muth (1961)].

In the early 1980s, researchers began to use the dual criteria of accuracy and association to evaluate earnings forecasting models. Fried and Givoly (1982) and Brown et al. (1987a,b), respectively, used these same dual criteria to compare analysts' annual and quarterly earnings forecasts with those of univariate time-series models. These studies showed that analysts' earnings forecasts are 'better' than those of time-series models when both criteria are used and suggested that analysts' earnings forecasts should be used in lieu of time-series model forecasts, when a proxy for the market's earnings expectations is required. When analyst data became widely available in machine-readable form, academics began to use analysts' earnings forecasts in lieu of time-series model forecasts to proxy for the market's unobservable earnings expectation.

The remainder of this article proceeds as follows. Section 2 discusses a branch of the earnings forecasting literature which continued to evolve without direct links to capital markets research. It examines the time-series properties of annual and quarterly earnings: what happens to predictive accuracy when additional information, beyond earnings, is allowed for in the information set; the analysts' earnings expectation process; how analysts' earnings forecasts can be improved; biases in analysts' earnings forecasts; determinants of analyst following. Section 3 examines the relation between accuracy and association; past quarterly earnings numbers and post-earnings announcement drift; analyst behavior and post-earnings announcement drift; forecast convergence and post-earnings announcement drift; the relation of analysts' forecasts to abnormal returns. The earnings response coefficient literature, discussed in Section 4, examines proxies for earnings surprise; determinants of earnings response coefficients (ERCs); the functional form of the ERC estimation equation; stock-price and earnings expectations.

Sections 2, 3 and 4 summarize and critique the literature. and offer some guidance for future research. Section 5 focuses on some directions for future research. Included therein is the role of analysts' earnings forecasts as inputs for stock-price recommendations; the role of analyst expectational data in post-earnings announcement drift studies; the role of expectational data if forecast accuracy and association are (or are not) two sides of the same coin.

Section 6 provides implications for other branches of forecasting research. Special attention is paid to two notions: (1) the forecasting literature has recently developed a number of themes which have been addressed by the literature surveyed in this paper; (2) the intellectual focus of forecasting research can be sharpened, and its impact enhanced, if it broadens its perspective beyond examining forecasts as ends in themselves.

2. A continuation of the earnings forecasting literature

2.1. Time-series properties of earnings

One branch of earnings forecasting research
focused on the time-series properties of earnings numbers and lacked direct links to capital markets research. Nevertheless, the models developed by this literature have been used as measures of earnings expectations in capital markets studies. Foster (1977), Griffin (1977), Watts (1975) and Brown and Rozeff (1979a) advocated different Box–Jenkins (1976) ARIMA models of the quarterly earnings time-series process. The Box–Jenkins model uses \((p,d,q)\times(P,D,Q)\) notation, the Foster model is the \((100)\times(010)\) model, plus a constant. It is a first-order autoregressive model, determined after seasonally differencing the time-series of quarterly earnings numbers. The Griffin–Watts model is the \((011)\times(011)\) ARIMA model. Both its ordinary and seasonal components are moving average processes after taking first differences. The Brown–Rozeff model, expressed as \((100)\times(011)\) in ARIMA notation, employs the ordinary component of the Foster model (the first term in parentheses), and the seasonal component of the Griffin model (the second term in parentheses). Box and Jenkins (1976) represent the seasonal time-series process via the multiplicative model:

\[
\phi(B)\Phi(B^4)w_t = \theta(B)\Theta(B^5)\alpha_t + \theta_n
\]

where \(w_t\) is a stationary time-series; \(B\) is the backshift operator such that \(B^kw_{t-k}\), \(\phi(B)\) and \(\theta(B)\) are polynomials in \(B\), namely \(\phi(B) = 1 - \phi_1B - \ldots - \phi_pB^p\) and \(\theta(B) = 1 - \theta_1B - \ldots - \theta_qB^q\), \(\Phi(B^3)\) and \(\Theta(B^5)\), the seasonal parts of the model, have the form \(\Phi(B^3) = 1 - \Phi_1B^3 - \ldots - \Phi_pB^{3p}\) and \(\Theta(B^5) = 1 - \Theta_1B^5 - \ldots - \Theta_QB^{5Q}\), \(\alpha_t\) is an independent and identically distributed ‘white noise’ residual term with mean zero and variance \(\sigma_\alpha^2\), and \(\theta_n\) is a constant. The model is of order \((p,d,q)\times(P,D,Q)\). Autoregressive parameters are denoted by \(p\) and \(P\); moving average parameters by \(q\) and \(Q\); \(d\) and \(D\) are the degrees of ordinary and seasonal differencing required to achieve stationarity.

Griffin (1977) and Watts (1975) proposed the model:

\[
(1 - B)(1 - B^4)X_t = (1 - \theta_1B^4)(1 - \Theta_4B^4)\alpha_t
\]

where \(X_t\) denotes quarterly earnings per share. Brown and Rozeff (1979a) suggested the model:

\[
(1 - \phi_1B^4)(1 - \Theta_4B^4)\alpha_t
\]

The Foster (1977) model is a special case of the Brown–Rozeff (1979a) model, with \(\theta_4\) equal to zero.

In contrast with the Griffin–Watts and Brown–Rozeff models, which require the use of ARIMA software to estimate model parameters, the Foster model’s parameters are estimable using ordinary least squares (OLS). It can be estimated as:

\[
X_t - X_{t-4} = c + \phi_1(X_{t-1} - X_{t-5}) + \alpha_t
\]

where \(X_t\) is quarterly earnings in period \(t\), \(c\) is an intercept (constant term), \(\phi_1\) is a slope and \(\alpha_t\) is an error term. The ease with which these estimates can be made resulted in its being the most often used of the three ARIMA models.

These three ARIMA models formed the core of the quarterly earnings time-series model literature. Many studies have examined which model generates the most accurate quarterly earnings forecast. Benston and Watts (1978) provided evidence in favor of the Foster model, Lorek (1979) argued on behalf of the Griffin–Watts model, Collins and Hopwood (1980) and Bathke and Lorek (1984) provided evidence in favor of the Brown–Rozeff model. For over a decade, no other quarterly ARIMA model to be introduced was found to be more ‘accurate’, on average, than these three models.

Lee and Chen (1990) showed that these three ARIMA models can be improved by incorporating temporary, short-run and long-run structural changes. They argued that structural changes are commonplace and that statistical models incorporating them provide more accurate earnings forecasts than can be generated via the three ARIMA models. However, they did not find that their procedure was able to generate more accurate forecasts than those by Value Line analysts and they provided no evidence along the ‘association dimension’. Thus, one cannot infer that the Lee and Chen procedure generates ‘better’ earnings forecasts than can be provided by analysts.

Although it was commonly believed in the late 1970s that annual earnings follow a random walk

Collins et al. (1984) found a strong pattern of higher forecast errors in the fourth interim period for time-series models and financial analysts’ forecasts, suggesting that a different forecasting model may be needed for the fourth quarter than is used for the first three quarters.
(or random walk with drift) model, some researchers argued that annual earnings with extreme year to year changes were better described by a mean-reverting model [Brooks and Buckmaster (1976), Salamon and Smith (1977), Beaver and Morse (1978)]. The mean-reverting model, known as the ARIMA (0,1,1) or integrated moving average (IMA) (1,1) model, has been used in numerous subsequent studies by accounting researchers [Beaver et al. (1980, 1987), Collins and Kothari (1989)].

Kendall and Zarowin (1990), and Ramakrishnan and Thomas (1992) have shown that annual earnings are well-described by a first-order autoregressive process in earnings levels. In contrast with Brooks and Buckmaster (1976), who reject the random walk hypothesis only for extreme earnings changes, these studies suggest that the rejection of the random walk model is not confined to cases of extreme earnings changes. Ramakrishnan and Thomas (1992) show that this behavior has become more pronounced over time: the mean autocorrelations at the first lag in the excess earnings time-series (where \( X_t \) and \( d_t \) are net income and dividends, respectively, and \( R_t \) the required return on equity = \( 1.1 \)) are \(-0.03\) and \(-0.16\) for the two 20-year periods, 1951-1970 and 1969-1988, respectively. Nevertheless, neither study provided predictive evidence in a holdout sample, and there are numerous ways to generate a more accurate annual earnings forecast than the random walk IMA (1,1) or (autoregressive) AR (1) models, by expanding the information set beyond the time-series of past annual earnings numbers. This literature is discussed below.

2.2. Expanding the information set upon which annual earnings expectations are conditioned

Hopwood et al. (1982) showed that the three ARIMA quarterly earnings time-series models can be used to improve the predictive accuracy of the annual earnings number. More specifically, prior to observing the first interim (quarterly) earnings report of the fiscal year, one can use these ARIMA models to forecast the individual quarterly earnings numbers which, when summed, equal an annual earnings forecast which is 15–21% more accurate than is obtainable by extrapolating from the firm’s past annual earnings numbers alone. Hopwood et al. define the relative predictive accuracy of the annual versus quarterly models as:

\[
\frac{\sum_{j=1}^{4} (F_{A,j} - Actual,j)^2}{\sum_{j=1}^{4} (F_{Q,j} - Actual,j)^2}
\]

where \( F_{A,j} \) is the forecast from the annual model for year \( j \), and \( F_{Q,j} \) is the forecast from the sum of quarterly forecasts for year \( j \) (\( j = 1 - 5 \)), based on one of the three ARIMA models.

Beaver et al. (1980, 1987), Collins et al. (1987) and Freeman (1987) show that the random walk model can be ‘beaten’ by expanding the information set to include the firm’s stock price. Shroff (1992) shows that a composite model forecast, utilizing random walk and price-based model forecasts, is more accurate than a random walk model forecast when earnings variability is large relative to stock-price variability. These studies suggest that the firm’s stock price is based partly on expectations of future earnings, rather than simply on known, current and past, earnings. Consistent with this finding, Brown et al. (1985) show that the firm’s stock price is based on analysts’ expectations of future earnings and that analysts’ long-term earnings expectations are more valuation-relevant than their short-term earnings expectations.

Freeman et al. (1982) showed that the random
The random walk with drift model can be beaten by expanding the information set beyond the firm's past annual earnings to include its past stock-price and book rate of return. Based partly on these findings, Ou and Penman (1989a,b), Ou (1990), Lev and Thiagarajan (1991), Lev and Sougiannis (1992) and Penman (1992b) showed that non-earnings, financial statement data can be used to predict future earnings. Some of these studies also showed that abnormal returns can be obtained by using publicly available financial statement information, giving rise to a financial statement information anomaly. Ball (1992) suggests that the financial statement information anomaly is due to accounting ratios proxying for stocks’ expected returns. As evidence for this view, he cites Stober (1992), who showed that the Ou and Penman (1989a,b) algorithm can be used to generate abnormal returns that continue at an almost constant rate for 6 years beyond the earnings prediction date. Ball argues that if the abnormal returns persist for 6 years, they are likely to be related to risk factors, not to financial statement data. Greig (1992) and Holthausen and Larcker (1992) also challenge the Ou and Penman results.

In summary, time-series models confined to past earnings generally can be beaten by expanding the conditioning information set to include past quarterly earnings, stock prices, book rates of return, or other financial statement data. Thus, while the random walk with drift, IMA (1,1) and AR(1) models are reasonable characterizations of the annual earnings time-series process, they can readily be improved on once additional information beyond past annual earnings is allowed for in the conditioning information set. More work is needed to determine whether a financial statement information anomaly exists and if it does, whether it is more pronounced for certain firms and time periods than for others.

2.3. The analyst’s earnings expectation process

Research has provided insights into the process by which analysts formulate their earnings expectations. Some studies have examined why analysts’ earnings forecasts are relatively more accurate than those made by time-series models. Brown and Zmijewski (1987) show that the analyst’s earnings forecasting advantage is enhanced at a time of strikes. Their finding is consistent with the hypothesis that analysts are relatively better than time-series models at distinguishing among permanent, transitory and price-irrelevant earnings shocks [Ramakrishnan and Thomas (1991)]. However, they 'stack the decks' in favor of analysts by using as benchmarks those models which do not incorporate structural changes into the quarterly earnings generating process. While the Brown and Zmijewski results are intuitively appealing, their study should be replicated with a stronger time-series model benchmark and a more sophisticated methodology before one can reliably conclude that analysts are better than time-series models at distinguishing between earnings shocks with different valuation implications.

Fried and Givoly (1982) and Brown et al. (1987a) investigate whether an analyst's forecasting advantage relative to that of a time-series model is attributable to two information factors: (1) analysts have a contemporaneous information advantage — they utilize information available on the earnings announcement date other than the sequence of known quarterly earnings numbers; (2) analysts have a timing advantage — they utilize information acquired after the time-series model forecast initiation date (i.e. the earnings announcement date), such as management forecasts, macroeconomic data and industry variables. Fried and Givoly (1982) use annual earnings data from the, now defunct, Standard and Poor's Earnings Forecaster, and find that only the first (contemporaneous) information factor is significant. Brown et al. (1987a) use Value Line quarterly forecasts, and find both the timing and contemporaneous information factors to be significant. Nevertheless, neither study provides insights into the relative importance of alternative information sources for explaining the analyst’s forecasting advantage.

Brown et al. (1987c) use both Institutional Brokers Estimation System (I/B/E/S) consensus (mean) forecasts and Value Line forecasts, and argue that the analyst’s forecasting advantage relative to time-series models is attributable to three characteristics of the information set conditioning analysts’ expectations: (1) the amount of information available; (2) the precision of this information; (3) the correlation among the in-
formation variables. Using firm size, the homogeneity of analysts' earnings expectations and the number of lines of business (LOB), as proxies for the amount, precision, and correlation among the information variables, respectively, Brown et al. (1987c) show that the analyst's relative advantage in forecasting annual earnings is positively related to firm size and the homogeneity of analysts' expectations. Finding no relation between the analyst's relative earnings forecasting advantage and the number of LOB, they suggest that the number of LOB is too crude a proxy for the correlation among the information variables to allow for definitive findings. Their reasoning is as follows: “Suppose that (analysts possess) \( n \) information signals (which) relate to \( m \) lines of business. If \( m \) is small, the \( n \) information signals will be highly correlated . . . if \( m \) is large and each of the \( n \) information signals is randomly assigned to one of the \( m \) lines of business, the \( n \) information signals will tend to represent more diverse types of information”. This argument is not very persuasive, as there is no reason to believe that each of the \( n \) information signals is randomly assigned to one of the \( m \) lines of business.

Employing Value Line quarterly forecasts, Kross et al. (1990) also use the number of LOB to proxy for the correlation variable and find it to lack explanatory power. One explanation for the poor LOB results is that the variable is significantly correlated with firm size and the homogeneity of analysts' expectations [Brown et al. (1987c), p. 60]. Another explanation for the poor LOB results is that the correlation among the information variables is not an important determinant of analyst forecast superiority. Nevertheless, Branson and Pagach (1993) show that the Value Line analyst's predictive advantage vis-à-vis the Brown-Rozef (1979a) model, is significantly positively related to LOB for two- and three- (but not one) quarters-ahead forecast horizons. Additional research is needed to determine whether the Brown et al. (1987c) theory is poorly specified, the number of LOB is a poor proxy for the correlation variable, or both.

Kross et al. (1990) show that the analyst's advantage in forecasting annual earnings increases with the firm's earnings variability and the amount of coverage by the Wall Street Journal. This provides additional evidence that analysts possess an informational advantage vis-à-vis time-series models. Similarly, Kim and Schroeder (1990) suggest that analysts utilize a wide variety of non-earnings information sources when forecasting annual earnings. They show that analysts anticipate discretionary accruals in earnings reports of firms with earnings-based bonus plans.

Collins et al. (1987) and Freeman (1987) extend the work of Beaver et al. (1980, 1987) and Beaver et al. (1987) by examining the relation between firm size and the predictive advantage of price-based forecasts versus predictions of a naive earnings expectation model. Arguing that stock price is a more efficient aggregator of information for larger firms, Collins et al. and Freeman show that price-based forecasts for larger firms have a predictive advantage vis-à-vis smaller firms. Larger firms have richer information environments than smaller firms, owing to the information acquisition and dissemination activities of analysts and institutional investors [Atiase (1985), Bamber (1987), Bhushan (1989)]. Thus, it is relatively more difficult for larger firms' managers to withhold their private information [Brown and Kim (1993)], and larger firms' stock prices incorporate information relatively more rapidly.

Collins et al. (1987) and Freeman (1987) interpret their findings as being consistent with a firm-size differential information environment hypothesis. However, the random walk model is a weak benchmark for forecasting annual earnings (e.g. it can be improved on simply by using the firm’s past quarterly earnings numbers in lieu of its past annual earnings numbers [Hopwood et al. (1982)]), so these results should not be considered as definitive evidence of a firm-size based explanation. Before the evidence can be considered definitive, it is necessary to demonstrate that the firm-size results are robust to stronger time-series benchmarks, such as ones incorporating past quarterly earnings numbers. If the relative predictive advantage of using quarterly earnings in lieu of annual earnings is greater for smaller firms, the firm-size results may not be robust to this stronger time-series benchmark.

Brown et al.'s (1985) finding that stock price is a leading indicator of analysts' earnings forecast revisions suggests that the analysts' information advantage may be attributable to the incorpora
tion of lagged stock prices into their earnings forecasts. If so, the analysts’ comparative advantage over univariate time-series models may arise from their utilization of public rather than private information. However, a price-based explanation for the analyst’s comparative advantage is unlikely. Stickel (1990) shows that the change in the consensus (mean) estimate and the analyst’s deviation from the consensus estimate are much more important determinants of analysts’ earnings forecast revisions than is the firm’s lagged stock price. Thus, the analyst’s comparative earnings forecasting advantage appears to result at least partly from the utilization of firm-specific, private information, not public information reflected in stock price. The evidence that analysts possess private information facilitating their earnings predictions is consistent with the finding that analysts possess private information enabling them to generate superior forecasts of firms’ future stock prices [Copeland and Mayers (1982), Coggin and Hunter (1983), Dimson and Marsh (1984), Elton et al. (1986), Brown et al. (1991)]. However, little is known regarding how much of the analysts’ predictive advantage is due to the utilization of private rather than public information.

In summary, the analysts’ earnings forecasting advantage relative to time-series models is partly attributable to their private information acquisition activities, which may enable them to better distinguish between permanent, transitory and price-irrelevant earnings shocks. Their comparative advantage is greater when the forecast is for a larger firm, with more information acquisition activities, greater earnings variability and more homogenous analyst expectations. Additional work is needed to ascertain whether the correlation among information variables is a viable factor explaining the analysts’ comparative advantage. Moreover, the validity of the firm-size explanation and the role of public versus private information acquisition in explaining the analysts’ predictive advantage await future study.

2.4. Improving analysts’ earnings forecasts

Several studies have examined whether analysts’ earnings forecasts can be pooled with those of time-series models to generate relatively more accurate earnings forecasts than can be made by either analysts or time-series models individually. Newbold et al. (1987) show that pooling Value Line earnings forecasts with forecasts generated via the Brown and Rozell (1979a) quarterly earnings time-series model results in more accurate earnings forecasts than produced by either the Value Line analyst or the Brown–Rozell model individually. Conroy and Harris (1987), Guerard (1989), Lee and Chen (1990) and Lobo (1991) use different univariate time-series model forecasts, and show that predictive ability can be enhanced by pooling time-series model forecasts with analysts’ forecasts. Elgers and Murray (1992) show that I/B/E/S consensus forecasts, when pooled with stock-price based forecasts using the procedure of Beaver et al. (1980, 1987), generate more accurate forecasts than are available using either model individually. Stober (1992) shows that the summary financial statement measure (Pr) derived by Ou and Penman (1989a,b) works best when Pr indicates ‘buy’ and I/B/E/S consensus analyst revisions suggest ‘sell’.

Several studies interpret their own evidence as suggesting that analysts do not use all the information in financial statements and stock prices when formulating their annual earnings expectations. However, one cannot conclude that this is the case since these studies use consensus, rather than individual, analyst earnings expectations. As discussed below, some of the forecasts included in the consensus forecast are not conditional upon the financial statement information that these studies maintain is ignored by the analysts. The contention that analysts disregard information in financial statements (or stock prices) is warranted only if the consensus analyst forecast is based on individual analyst forecasts made after the date that the financial statement (or stock-price) data are available [Brown and Han (1992)].

analyst forecasts and show that analysts' earnings forecasts do ignore information reflected in stock prices prior to the forecast-release date. They conclude that analysts' earnings forecasts do not incorporate all the information in prior stock-price changes, suggesting that analysts are inefficient in collecting and/or interpreting publicly available information.

A finding that analysts ignore publicly available information is unsatisfactory to capital markets researchers who advocate semi-strong form market efficiency [Fama (1970)], but it is satisfactory to behavioral researchers who maintain that people consistently overweight some cues and underweight others [Tversky and Kahneman (1984), Gilovich et al. (1985), Mear and Firth (1987), Hunter and Coggin (1988), DeBondt (1993)]. Abarbanell (1991) suggests that analysts have incentives to provide new forecasts only when they obtain information which is independent of prior stock-price changes. He maintains that this strategy makes it easier for investors to infer the analyst's private information: "...private information is more easily inferred by investors if it is not combined with other signals whose information content is open to individual interpretation (p. 164)". This view is controversial as other studies have taken an opposite view. For example, Kane et al. (1984) suggest that it is easier to infer the valuation implications of dividend (earnings) information which is combined with and corroborated by earnings (dividend) information. While the descriptive validity of Abarbanell's scenario versus the behavioralist interpretation awaits additional research, analysts do appear to ignore publicly available data already incorporated in past earnings and stock prices.

Some studies have examined ways to improve analysts' earnings forecasts without pooling them with other information. O'Brien (1988) shows that the most recent I/B/E/S analysts' earnings forecast is more accurate than the consensus (mean) forecast. Although this appears to contradict the forecast aggregation principle that aggregation improves predictive accuracy by reducing idiosyncratic error, studies finding evidence consistent with the aggregation principle [Ashton and Ashton (1985), Libby and Blashfield (1978), Winkler and Makridakis (1983)] examined equally recent forecasts.

Analysts' earnings forecasts are not usually equally recent. They make their forecasts throughout the year, rather than at any set time, such as on earnings announcement dates. As some forecasts included in the consensus may be more than 6 months old [O'Brien (1988)], the analyst ignores two quarterly earnings reports. Since analysts' earnings forecasts can be improved simply by substituting in known quarterly earnings numbers for their previous expected values, leaving intact forecasts for the remainder of the year [Brown and Rozell (1979)], it should be possible to improve analysts' consensus forecasts by deleting old estimates.

Brown (1991) shows that earnings forecast accuracy can be improved by discarding old earnings forecasts. Using detail Zacks Investment Research data, Brown finds that each of three "timely composites" (i.e. the most recent forecast, an average of the three most recent forecasts and the 30-day average) is more accurate than the mean forecast. Moreover, the comparative advantage of each timely composite depends on firm size; the most recent forecast is approximately as accurate as the 30-day average for small firms, but the 30-day average is significantly more accurate than the most recent forecast for large firms. These results can be interpreted as follows. The aggregation principle pertains to the 30-day average of large firms because these firms are followed by many analysts. In contrast, small firms are followed by few analysts and even fewer analysts make their earnings forecasts within 30 days of each other. Brown's results suggest that the aggregation principle pertains to earnings forecasts which are equally timely, but not to those made at different points of time.

Several studies have examined if there exists a superior analyst. Using a small sample of Value Line earnings forecasts, Brown and Rozell (1980) conclude that superior forecast ability is

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5 Lys and Sohn (1990) use detailed Zacks Investment Research, Inc. data. Abarbanell (1991) uses Value Line data, which represent one or two analyst forecasts made on the same date, approximately 1 week before the Value Line Investment Survey date.

6 Brown does not directly examine the number of analysts following the firm. However, analyst following is highly positively correlated with firm size [Shores (1990)].
not evident. Using a much larger sample of I/B/E/S data and a more powerful methodology, O'Brien (1990) reaches the same conclusion. However, Stickel (1992) uses a large sample of Zacks Investment Research data and concludes that members of the Institutional Investor All American Research Team are superior earnings forecasters. Unlike O'Brien (1990), he uses a matched pair design which fully controls for forecast recency. Using I/B/E/S data and a more powerful control for forecast recency than O'Brien (1990) and Sinha et al. (1993) conclude that superior analysts do exist.

Using detail Zacks Investment Research data, Stickel (1990) shows that analysts' annual earnings forecasts can be improved by updating them with publicly available data. Indeed, Stickel (1993) demonstrates that these updated forecasts are more accurate than those of the three timely composites examined by Brown (1991). Thus, the aggregation principle pertains to earnings which are made at different points in time, provided that they are updated with publicly available data.

In summary, there are numerous ways to improve analysts' earnings forecasts, such as by pooling them with time-series model forecasts, stock prices, or financial statement data. Consensus estimates can be improved by discarding old forecasts and by including updated forecasts in the consensus. Analysts do not appear to process publicly available information efficiently and there appears to be some difference in their abilities to forecast earnings. Why analysts do not process information efficiently and what is the nature of the information they underweight/overweight are interesting topics for future research.\footnote{Alternative interpretations of the evidence are that the testing methodologies lack sufficient power or improper assumptions are made regarding market efficiency (e.g. zero information acquisition, dissemination and processing costs).}

2.5. Biases in analysts' earnings forecasts

Several studies have examined biases in analysts' earnings forecasts. Fried and Givoly (1982) and O'Brien (1988) show that analysts' earnings forecasts generally are overly optimistic. Butler and Lang (1991) find the analysts' degree of optimism or pessimism to persist over time and that the degree of persistence is independent of the level of the firm's earnings predictability (as defined by Value Line's earnings predictability ranking). Biddle and Ricks (1988) show that analysts were overly optimistic regarding the earnings of firms that adopted last-in-first-out (LIFO) in 1974. All of these studies suggest that analysts may intentionally generate optimistic forecasts.\footnote{Fried and Givoly utilize Standard and Poor's Earnings Forecaster data; O'Brien and Butler and Lang use detail I/B/E/S data; Biddle and Ricks use data from Standard and Poor's Earnings Forecaster.} However, Affleck-Graves et al. (1990) show that disinterested judges exhibit significant optimistic biases. This suggests that analysts' biases may be attributable to judgmental heuristics employed in earnings per share predictions, and thus are, partly, unintentional.

Sell-side analysts are more optimistic when the firms they work for either underwrite the securities of the companies whose earnings they estimate [Lin and McNichols (1991)] or act as the companies' investment bankers [Dugar and Nathan (1992)]. Sell-side analysts are employed by brokerage firms and their forecasts are reported externally. Buy-side analysts are employed by banks, insurance companies and pension funds, and their forecasts are used internally by the firm's portfolio managers. Sell-side analysts are more likely to possess an optimistic bias because they are paid, in part, by the amount of commissions they generate [Dorfman (1991)]. It is much easier to get clients to buy stocks than to sell them (especially to convince clients to short-sell stocks they do not own). Moreover, if the firms that employ them underwrite securities or act as the firm's investment bankers, sell-side analysts have additional incentives to provide optimistic forecasts so as not to upset their firms' clients [Siconolfi (1992)]. Dugar and Nathan (1992) show that the stock market is aware of and adjusts for this bias. However, they do not determine whether the adjustment is complete, so it is unclear whether capital markets fully extract the bias.

Francis and Philbrick (1992) show that Value Line analysts are overly optimistic, in spite of the fact that Value Line Inc. neither underwrites securities nor provides investment banking ser-
services. They argue that analysts are pressured by managers to be overly optimistic in order to remain privy to managers' asymmetric information, but an alternative explanation for their result is the Affleck-Graves et al. (1990) finding that the optimistic bias is unintentional. A stronger test of analyst optimism would be to examine the biases, if any, of buy-side analysts, as it is not evident that these analysts have incentives to be overly optimistic.

Using I/B/E/S consensus data, DeBondt and Thaler (1990) conclude that analysts over-react to extreme earnings changes and returns. Although this is not mentioned by the authors, analysts are more likely to over-react if they believe that annual earnings follow a random walk with drift process (e.g. analysts ignore the evidence that annual earnings revert to their mean values, especially when year to year earnings changes are extreme). Klein (1990) argues that analysts' over-reaction to extreme earnings changes and returns requires them to under-predict annual earnings after large stock price declines and over-predict earnings after large stock-price increases. Her findings, however, are the opposite (i.e. analysts' earnings estimates are overly optimistic after stock-price declines). She interprets her evidence as suggesting that managers whose firms face adverse conditions press analysts to make overly optimistic forecasts. However, in the light of my conversations with Value Line personnel, I would suggest that analysts tend to be overly optimistic when a firm experiences adverse times without being pressured by managers. Analysts do not often predict that firms will fail; they are more likely to expect a reversion to the mean (i.e. better times ahead). Behaviorists would characterize such behavior as underweighting (overweighting) recent (past) cues.

In summary, the evidence suggests that analysts do possess a positive bias; their degree of optimism or pessimism persists through time; and their optimistic bias is greater when firms employing them are underwriters or investment bankers of the companies whose earnings they estimate. Further research is needed to ascertain how much of the bias is unintentional; the causes of intentional analyst bias; whether capital markets fully extract these, intentional and unintentional, biases.

2.6. Modeling analyst following

Bhushan (1989) concludes that the number of analysts following a firm is positively related to the number of institutions holding its shares, the percentage of its shares held by institutions, the variance of its daily returns, the R-squared from the market model regression of its returns on the market return, and the market value of its equity. His arguments regarding an expected positive relation between analyst following and both the variance of the firm's daily stock-price returns and the R-squared from the market model regression (i.e. the regression of the firm's daily stock-price returns on the return of a value-weighted market portfolio) are as follows. Private information is useful and it is more useful for firms with higher return variability. The expected trading profit is an increasing function of the probability of obtaining a large deviation between the expected return conditional on all known information and the expected return conditional on public information. The expected trading profit based on private information is higher for firms with higher return variability and the aggregate demand for analyst services is an increasing function of the firm's return variability. Bhushan argues that a firm's marginal information acquisition cost is lower if it has a higher R-squared from a market model regression, and that an increase in the R-squared between firm and market returns is likely to increase total expenditures on analyst services. However, his use of cross-sectional data to test a temporal model makes it difficult to interpret his results.

Brennan and Hughes (1991) show that the number of analysts following a firm is positively related to firm size and the variance of return, and negatively related to share price. They contend that managers with favorable firm-specific private information split their shares in order to reveal their favorable private information to investors: lower priced shares cause increased following by investment analysts and increased following by analysts increases the timeliness of firm-specific information disclosures. Brennan and Hughes's hypothesis has not yet been tested. One way to test it would be to examine whether firms, after splitting their shares, provide investors with more timely information, such as mak-
ing their quarterly earnings announcements relatively closer to the fiscal quarter-end to which the earnings pertain.

O’Brien and Bhushan (1990) investigate the joint analyst–institution decision process, and show that the relation between analyst following and firm size is eliminated once analysts’ decisions to follow firms and institutional investors’ decisions to hold these firms in their portfolios are jointly determined. They find that changes in analyst following are positively related to net entry of firms into the industry and regulation, and negatively associated with the amount of pre-existing analyst following and changes in volatility. Volatility is defined as the residual standard error from a market-model regression. The authors maintain that analysts prefer regulated industries because regulatory oversight and disclosures provide operating information that supplements financial disclosures, reducing analysts’ information acquisition costs. While not mentioned by the authors, increased disclosures by regulated firms are likely to reduce the incremental value of analysts’ information gathering activities, making it less attractive for them to follow these firms. O’Brien and Bhushan’s results suggest that analyst following should be modelled jointly with institutions’ decisions to avoid drawing erroneous inferences regarding the determinants of analyst following.

The lack of robustness of the Bhushan (1989), Brennan and Hughes (1991), and O’Brien and Bhushan (1990) findings to the manner in which the decision process is specified suggests that analyst following may be related to firm size if factors additional to the analyst–institution decision process are considered. The lack of robustness to model specification implies that the theoretical relation between analyst following and firm size needs further elaboration.

### 3. Some evidence of the impact of earnings forecasting research on capital markets research

#### 3.1. Accuracy versus association of forecast surprise with abnormal returns

There is mixed evidence as to whether the model that is best in the accuracy dimension is best in the association dimension (i.e. has the strongest association with abnormal returns). Fried and Givoly (1982) focus on annual earnings, and show that forecasts generated by the Standard and Poor’s Earnings Forecaster outperform two univariate time-series models in both dimensions. Bathke and Lorek (1984) examine the quarterly earnings forecasts of five univariate time-series models, and conclude that the Brown and Rozell (1979a) ARIMA model is best in both dimensions. Brown et al. (1987a,b) show that quarterly earnings forecasts by Value Line analysts are better than those of five univariate time-series models in both dimensions. Brown (1991) and Brown and Kim (1991) use Zacks Investment Research data to show that three timely composites are better than the consensus (mean) quarterly earnings forecast in both dimensions. Thus, several studies have obtained similar results using both the accuracy and association metrics.

Other studies find the opposite, namely that more accurate earnings forecasts do not generate earnings surprises which are more highly correlated with contemporaneous abnormal returns. In a seminal study, Foster (1977) examined six univariate time-series models of quarterly earnings and found the (100) × (010) model plus a constant to be best in the predictive ability dimension, but the seasonal random walk with drift model (i.e. the (000) × (010) plus constant model) to be best in the market association dimension. Hughes and Ricks (1987) and O’Brien (1988), respectively, use Standard and Poor’s Earnings Forecaster and I/B/E/S consensus data, and find analysts’ annual earnings forecasts to be better than time-series model forecasts in the predictive ability dimension, but not in the association dimension.

Philbrick and Ricks (1991) examine four sources of analyst data: Value Line, I/B/E/S, Standard and Poor’s Earnings Forecaster, and Zacks Investment Research. They find that the smallest absolute forecast errors are obtained by pairing Value Line forecasts with Value Line actuals and that the strongest associations, using a 3-day window, are obtained using Value Line actuals with Value Line or I/B/E/S forecasts. Their results suggest that the source of actual earnings per share (EPS) data is more important than the source of forecasted EPS data. This
finding may explain the disparity between studies using the same sources of forecasts and actuals [e.g. Brown et al. (1987a,b)] with those using different sources of forecasts and actuals [e.g. Hughes and Ricks (1987)]. The former, but not the latter, studies have found predictive ability and association to be two sides of the same coin.

Stickel (1990) shows that the accuracy of analysts’ annual earnings forecasts can be improved by updating them with publicly available data. Indeed, Stickel (1993) shows that these updated forecasts are more accurate than the three timely composites examined by Brown (1991). Stickel (1991) shows that earnings-forecast errors conditional upon these updated forecasts are less highly associated with abnormal returns than are forecast errors conditioned on the non-updated forecasts. Hopwood and McKeown (1990) find Value Line forecasts, for quarterly and annual earnings, to be more accurate than those of time-series models and the association evidence to be in favor of the Value Line analyst for annual, but not quarterly, earnings. Wiedman (1993) obtains the opposite result, that is, she finds a higher association for time-series model forecasts than for I/B/E/S forecasts for annual, but not quarterly, earnings.10

In summary, the findings of Fried and Givoly (1982), Bathke and Lorek (1984), and Brown et al. (1987a,b) suggest that accuracy and association are two sides of the same coin. However, the evidence of Foster (1977), Hughes and Ricks (1987), O’Brien (1988), Hopwood and McKeown (1990), Stickel (1991), and Wiedman (1993) suggests otherwise. The issue of whether the model that is best in the accuracy dimension is best in the association dimension is unresolved. If the best model in the association dimension is not best in the accuracy dimension, capital market efficiency in a conventional sense appears to be violated, provided that analysts are ‘the market’, that is they are the marginal price setters. However, such evidence is consistent with behavioral research showing that individuals improperly weight information. Alternatively, the evidence is consistent with a less stringent definition of market efficiency than the one which is generally employed.10 Additional research is needed to determine which of these scenarios is the most descriptively valid.

3.2. Past quarterly earnings numbers and post-earnings announcement drift

The concept of post-earnings announcement drift has a long history in accounting and finance literature [Ball and Brown (1968), Joy et al. (1977), Watts (1978), Foster et al. (1984)]. Ball and Brown showed that stock-price movements after annual earnings announcements are in the same direction as consecutive annual earnings changes. Thus, if annual earnings in year \( t \) exceed, or fall short of, those of year \( t - 1 \), stock prices move up, or down, after year \( t \) earnings are announced. Stock-price movements after year \( t \) earnings are announced are known as post-earnings announcement drift. Rendleman et al. (1987) showed that stock prices fail to capture fully the implications of current quarterly earnings for future earnings. Observing significantly positive adjacent quarterly autocorrelations, they argued that investors fail to recognize the implications of quarter \( t \) earnings for quarter \( t + 1 \) earnings.

Bernard and Thomas (1990) extend the Rendleman et al. analysis by incorporating implications of quarter \( t \) earnings for quarter \( t + 1 \) to \( t + 4 \) earnings. They show that the 3-day stock-price reaction around the time of quarterly earnings reports is predictable, conditional upon knowledge of the past four quarterly earnings numbers. More specifically, they argue that stock prices erroneously act as if quarterly earnings follow a seasonal random walk with drift model, when, in fact, quarterly earnings follow the (011) \( \times \) (011) Box–Jenkins ARIMA process [i.e. the model suggested by Brown and Rozeff (1979a)]. Thus, stock prices mistakenly behave as if the current quarterly earnings shock has a positive impact on earnings four quarters hence.

10 The conventional definition assumes zero costs of transacting, generating and processing information. Alternative explanations for model A being better than model B on the accuracy but not association dimensions include: accuracy and/or association are not correctly defined; models A and B are not independent; model C is better on both dimensions than either model A or B, but it is not included in the study.
and no impact on earnings one, two and three quarters hence. If stock-price movements conformed with the implications of the Brown-Rozef model, the stock-price reaction to the quarter \( t \) earnings number would incorporate the positive impact of the current shock on the next three quarterly earnings numbers, each with a lesser influence, and possibly a negative impact on earnings four quarters hence. The current shock will exert a negative impact on earnings four quarters hence if the moving-average seasonal component more than offsets the autoregressive ordinary component. [Recall that the Brown-Rozef model in Box and Jenkins (1976) notation is \((100) \times (011)\)].

Re-examining the Bernard and Thomas (1990) result on a holdout sample, Bartov (1992) provides predictive evidence which validates their findings. He shows that once the implications of past quarterly earnings for future quarterly earnings are controlled, the positive relation between unexpected earnings in quarter \( t \) and stock-price drift in quarter \( t + 1 \) disappears. He concludes that post-earnings announcement drift is fully explained by the failure of the market to correctly characterize the time-series process of earnings.

The failure of stock prices to fully capture the time-series properties of the quarterly earnings generating process gives rise to the 'cockroach theory' of earnings surprises — good/bad-news quarterly earnings reports precede other good/bad-news quarterly earnings reports. Similar to cockroaches, you never find just one of them! Bernard and Thomas (1990) maintain that the expected number of 'cockroaches' is five — the current one and the four subsequent ones, where the second and third subsequent earnings shocks are smaller in size than their immediate predecessors, and the fourth subsequent earnings shock is opposite in sign to the current one.

In summary, there is considerable evidence that stock prices fail to capture the implications of current quarterly earnings for future quarterly earnings. The failure of stock prices to fully capture the time-series properties of the quarter-

\[ \text{ly earnings generating process appears to violate semi-strong market efficiency [Fama (1970)]}. \] Whether the anomaly occurs, and, if so, why, are interesting topics for future research.

### 3.3. Analyst behavior and post-earnings announcement drift

Mendenhall (1991) shows that: (1) analysts underestimate the serial correlation in quarterly earnings, (2) investors use analysts' earnings forecast revisions to reassess the persistence of their previous forecast errors and (3) investors systematically underestimate the persistence of their previous forecast errors. Assuming that stock prices capture security analysts' earnings expectations, Mendenhall's results are consistent with those of Bernard and Thomas.\(^{12}\)

Similar to Mendenhall's results regarding quarterly earnings, but in contrast with an earlier study of annual earnings by Givoly (1985), Ali et al. (1992) find that analysts generally underestimate the permanence of the current annual earnings surprise with regard to future annual earnings.\(^{13}\) More specifically, Ali et al. show that analysts generally are overly optimistic regarding the subsequent year's annual earnings and that their annual earnings forecast errors display significantly positive serial correlation. Givoly found analysts' forecasts to be unbiased and their prediction errors to be serially uncorrelated. However, his sample is much smaller than that of Ali et al. (i.e. Givoly's results were based on as few as 378 firm-years; Ali et al.'s findings were based on 3184–5305 firm-years). The latter results appear to be relatively more credible, given the study's larger sample and more powerful methodology.

Using Value Line data, Abarbanell and Ber-

\[ \text{\footnote{\textbf{Stock prices do not fully capture analysts' expectations, but the degree of proximity should be close enough to make the Mendenhall (1991) and Bernard and Thomas (1989, 1990) results reasonably consistent with each other. As evidence that stock prices do not fully capture analysts' expectations, see Abdel-khalik and Ajinkya (1982) and Elton et al. (1981), who show that analysts' forecast revisions led stock price changes. Their respective sources of analyst forecasts are Merrill Lynch's Option Alert and I/B/E/S consensus data.}}\]

\[ \text{\footnote{\textbf{Mendenhall uses Value Line data; Givoly uses Standard and Poor's Earnings Forecaster detail data; Ali et al. use I/B/E/S consensus (median) data.}}\]
nard (1992) show that analysts' earnings forecasts under-react to recent earnings announcements in a manner similar to the 3-day stock-price under-reaction observed by Bernard and Thomas (1990). They conclude that security analysts' behavior is, at best, only a partial explanation for stock-price under-reaction to earnings and, hence, post-earnings announcement drift. Their conclusion is consistent with the evidence of Brown and Rozeff (1979b), who showed that analysts do not act as if the quarterly earnings generating process is a seasonal random walk with drift. In order for analysts' behavior to explain post-earnings announcement drift, analysts would have to act as if the earnings generating process was a seasonal random walk with drift. As mentioned earlier, Bernard and Thomas (1990) maintain that stock prices erroneously act as if quarterly earnings follow a seasonal random walk model with drift (seasonal submartingale) model. Both Brown and Rozeff (1979b) and Abarbanell and Bernard (1992) show that, similar to the Foster (1977) model, analysts act as if the quarterly earnings time-series process is autoregressive. Thus, it is not surprising that security analysts' behavior only partly explains the Bernard and Thomas (1990) results. Additional work is needed to further our understanding of the relation between analyst behavior and post-earnings announcement drift.

3.4. Convergence of analysts' expectations and post-earnings announcement drift

Some studies have examined the relation between earnings announcements and the convergence of analysts' expectations of future earnings. Bayesian theory suggests that earnings announcements generally increase the precision of individuals' estimates of future earnings numbers. The dispersion among individuals' earnings expectations is often used to proxy for the precision of individuals' estimates of future earnings [Ajinkya and Gift (1985), Brown et al. (1987c)]. Morse et al. (1991) examine this issue with I/B/E/S consensus (mean) forecasts and conclude that earnings announcements decrease the homogeneity of analysts' expectations of future earnings. Their results are inconsistent with their intuition, Bayesian theory and the time-series properties of earnings. The joint evidence that the quarterly earnings generating process is autoregressive [Lipe and Kormendi (1993)], and that analysts act as if the quarterly earnings generating process is autoregressive [Brown and Rozeff (1979b)], implies that earnings announcements should increase the precision of analysts' earnings expectations. The intuition is that each individual revises his/her forecast in the direction of his/her error (actual minus forecast). As shown by Morse et al. (1991), unless the errors are very large, the homogeneity of analysts' forecasts of future earnings will increase after observing current earnings.

Brown and Han (1992) argue that the Morse et al. results are due to their use of consensus (mean) analyst forecasts. Since analysts' earnings forecasts are not all made at the same point in time [O'Brien (1988)], some of the individual forecasts included in the consensus obtained after the earnings announcement were dated prior to the earnings announcement. In other words, not all forecasts included in the Morse et al. study were conditioned on the earnings announcement that the analysts supposedly had as inputs into their decision models. Brown and Han (1992) use detail I/B/E/S forecasts dated after the earnings announcement, and show that earnings announcements generally increase the homogeneity of analysts' expectations of future earnings. Consistent with Bayesian theory and Morse et al.'s intuition, Brown and Han find that analysts' expectations of future earnings become more homogenous only when earnings surprise is very large (i.e. for the top decile of earnings surprise).

The joint evidence that timely composites of analyst earnings estimates are more accurate than the consensus (mean) analyst estimate [O'Brien (1988), Brown (1991)], that errors conditional upon timely composites of earnings are relatively more highly associated with abnormal returns [Brown and Kim (1991)] and that analysts' expectations of future earnings become more homogenous upon observing current earnings when using individual, but not consensus, analyst forecasts [Brown and Han (1992)], suggests that researchers should use individual analysts' forecasts in lieu of consensus analysts' forecasts when requiring a proxy for the market's earnings expectation or the precision of individuals' expectations. Given that I/B/E/S and
Zacks Investment Research now have increased access to these data, it is likely that future research will rely more on individual analyst data.

3.5. Analyst forecasts and abnormal returns

Elton et al. (1981) provide evidence that investors cannot earn abnormal returns by selecting stocks based on analysts’ consensus growth forecasts. In contrast, Givoly and Lakonishok (1979), Abdel-khalik and Ajinkya (1982), Hawkins et al. (1984), Freeman and Tse (1989), and Beneish (1991) show that consensus analyst forecast revisions can be used to predict subsequent abnormal returns. A potential reason for the discrepancy is that Elton et al. did not examine forecast revisions. It would be instructive to investigate whether this is the reason for the discrepancy in results between Elton et al. and the other studies, and if larger profits can be made by using timely analysts’ forecasts, those pooled with time-series model forecasts and/or those updated using the Stickel (1990) procedure.

It also would be interesting to determine whether larger profits can be made by using timely, or updated, analyst estimates in lieu of the consensus estimate. Stickel’s (1991) evidence may be instructive in this regard. Showing that the analyst’s current outstanding forecast is a better measure of the market’s earnings expectation, in the association dimension, than is an updated forecast, he uses this result to create a profitable trading strategy that predicts changes in outstanding forecasts. Additional research is needed to reveal how and why analyst expectation data can be used to produce abnormal returns.

4. Earnings response coefficient literature

4.1. Proxies for earnings surprise

The earnings response coefficient is “the coefficient relating the surprise (new information) in accounting earnings to abnormal stock returns” [Easton and Zmijewski (1989)]. The ERC directly links earnings forecasting research to capital markets research because the definition of earnings surprise is conditional upon an earnings expectations model. ERC studies often require a proxy for the earnings persistence factor, which relates changes in expected future earnings to current earnings surprise, because, in theory, the valuation implication of an earnings number (the ERC) is positively related to its degree of permanence (the earnings persistence parameter). Studies have not been uniform regarding the ARIMA model chosen to estimate the earnings persistence parameter. Some of the assumed ARIMA models and their advocates are: ARIMA (0,1,1) [Beaver et al. (1980)], ARIMA (0,0,1) [Miller and Rock (1985)], ARIMA (2,1,0) [Kormendi and Lipe (1987)], and ARIMA (1,0,0) [Ramakrishnan and Thomas (1992)]. Surprisingly, little work has been done examining the sensitivity of ERC estimates to alternative ARIMA model specifications. [See Kendall and Zarowin (1990) for some limited evidence on this issue.] The external validity of this research would be enhanced (or lessened) considerably by showing that the results are (or are not) robust to alternative ARIMA model specifications.

Easton and Zmijewski argue that the analyst’s earnings revision coefficient (i.e. the coefficient relating current earnings to analysts’ estimates of future earnings) is an explanatory variable of ERC. They document a positive association between the ERC and the analyst’s earnings revision coefficient, and a negative association be-

\[
\frac{1 - \sum_{i=1}^{q} \theta_i}{\left(R - 1 - \sum_{i=1}^{p} \phi_i \frac{R}{R}ight)} = \text{ERC}
\]

where \( \phi_i \) is an autoregressive coefficient of order \( i \); \( \theta \) is a moving average coefficient of order \( j \); \( p, d \) and \( q \) are orders of the autoregressive process, differencing and moving average processes, respectively; \( R \) is \( 1 + \) the cost of capital.
between ERC and systematic risk. The authors rely on the earnings capitalization model of Miller and Modigliani (1961) to test their hypotheses that ERCs are increasing in the revision parameter and decreasing in risk. The revision parameter and risk are positively correlated with the numerator and denominator of the earnings capitalization model, respectively. The authors include firm size to control for measurement error in their proxy for unexpected earnings and not to test a hypothesis. They use the analysts' consensus (mean) earnings estimate to proxy for expected earnings and current earnings surprise to estimate the ERC. Both of these metrics may need reconsideration in light of recent evidence.

Regarding the use of consensus forecasts, the evidence of Brown (1991) and Brown and Kim (1991) suggests that expected earnings and earnings forecast revisions may be sensitive to the utilization of timely composite forecasts in lieu of consensus estimates. With regard to the use of current earnings surprise to estimate the ERC, Bernard and Thomas (1990), Wiggins (1990), and Bartov (1992) show that abnormal stock-price movements at the time of earnings announcements are related to current earnings and the four most recent quarterly earnings numbers. Cornell and Landsman (1989) and Abdelkhalik (1990) show that forecast revisions provide incremental explanatory power in a regression of abnormal returns on earnings surprise. These papers use I/B/E/S consensus (mean) forecasts and Value Line forecasts as proxies for the market's (unobservable) earnings expectation. Kothari and Sloan (1992) show that the ERC from a regression of returns on contemporaneous earnings changes is biased towards zero and that the bias is mitigated by including leading-period returns in the ERC estimation equation. Thus, ERC studies confined to current earnings [e.g. Kormendi and Lipe (1987), Collins and Kothari (1989), Easton and Zmijewski (1989)] are likely to suffer from an omitted variable problem, causing inefficient and possibly biased ERC estimates.

In summary, ERC studies using a short window [e.g. Easton and Zmijewski (1989)] require a precise measure of earnings response. The issue of narrow versus wide windows is discussed further in Section 4.3. Additional research is needed to determine whether the results of studies modeling ERCs are robust to ERC estimates incorporating timely earnings forecasts, lagged quarterly earnings, revisions of future quarterly earnings and alternative specifications of the earnings time-series process.

4.2. Determinants of ERCs

Collins and Kothari (1989) find that ERCs increase in economic growth and/or time-series persistence [Kormendi and Lipe (1987)], and decrease in interest rates and risk. Lipe (1990) shows that the ERC is positively related to both the predictability of the earnings series and the time-series persistence of earnings. The forecasting literature as it pertains to the time-series properties of earnings is relevant to the Collins and Kothari (1989) and Lipe (1990) studies. These studies, respectively, assume, but do not test, that the time-series process of annual earnings follow an ARIMA (0,1,1) [Beaver et al. (1980)] and ARIMA (2,1,0) [Kormendi and Lipe (1987)] process. However, Lipe and Kormendi (1993) show that annual earnings follow a fourth-order autoregressive process and that a dollar of year t earnings surprise leads to an approximately 80-cent revision in year t + 1 earnings. The robustness of the Collins and Kothari (1989) and Lipe (1990) results to alternative definitions of earnings persistence, such as the one advocated by Lipe and Kormendi (1993), awaits further research.

Brown and Zmijewski (1987) find that ERCs are smaller during strikes than at other times. This finding is consistent with the joint hypothesis that price-irrelevant and transitory earnings are higher during strikes, and that the capital market assigns a smaller multiplier to these earnings components [Ramakrishnan and Thomas (1991)]. Collins and DeAngelo (1990) find ERCs to be higher during proxy contests and lower after proxy contests than at other times. They consider the former result as surprising, because earnings management during proxy contests should lower ERCs and the latter result as con-

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10 Lipe and Kormendi consider the general ARIMA (p,d,q) model, set d = 1, q = 0, and focus on the effects of changing p, the order of the ARIMA (p,1,0) model. They estimated the parameters for the first through tenth orders, but found most of the improvements to occur by the fourth order.
sistent with firms taking a 'big (earnings) bath after experiencing management changes [Elliott and Shaw (1988)]. Choi and Jeter (1992) show that a firm's ERC declines significantly after issuing qualified audit reports for a sample of 'subject-to' and consistency qualifications. Their results are consistent with the hypothesis that audit qualifications reduce the market’s responsiveness to earnings announcements by altering perceptions of earnings noise and/or persistence. These studies suggest that a temporal estimate of a firm’s ERC should adopt a methodology incorporating systematic non-earnings shocks, such as that employed by Lee and Chen (1990).

Using the variance in analysts’ earnings forecasts, prior to a firm’s annual earnings announcements, to proxy for its ex ante uncertainty, Imhoff and Lobo (1992) examine the effect of ex ante earnings uncertainty on ERCs. Finding firms with relatively high ex ante uncertainty to exhibit little or no systematic stock-price change when earnings are announced, they conclude that dispersion in pre-announcement analysts’ earnings forecasts proxies for noise in the earnings signal. However, Kim and Verrecchia (1991) maintain that expected stock-price change is related to the resolution of ex ante uncertainty, not to its amount. The resolution of uncertainty is related to both the amount of ex ante uncertainty and the precision of the earnings announcement. A commonly used proxy for resolution of uncertainty is the change in dispersion of analysts’ earnings forecasts at the time of an earnings announcement, in lieu of the level of analyst dispersion prior to the announcement.

In summary, ERCs are positively related to economic growth and/or time-series persistence, and negatively related to interest rates and risk. They are smaller when earnings noise is high, earnings persistence is low and ex ante uncertainty is high. The impact of the resolution of ex ante uncertainty on ERCs await further study.

4.3. Functional form of the ERC estimation equation

Abdel-khalik (1990), Das and Lev (1991) and Freeman and Tse (1992) show that the relation between abnormal returns and unexpected earnings is non-linear. Abdel-khalik (1990) shows that a model relating abnormal returns to unexpected earnings is better specified if it includes the past and future revisions of earnings expectations in the estimation equation. Das and Lev (1991) show that the non-parametric procedure, locally weighted regression, yields significantly more explanatory power than ordinary least squares (OLS) in an abnormal return on unexpected earnings regression, especially for small earnings surprises. Freeman and Tse (1992) show that the marginal response of stock price to unexpected earnings declines as the absolute value of unexpected earnings increases. Assuming that the absolute value of unexpected earnings is negatively related to earnings persistence and that it is relatively easier to forecast permanent earnings than transitory earnings, they maintain that these two assumptions imply that transitory earnings surprises are concentrated in the tails of the unexpected earnings distribution. Their evidence is consistent with the view that the earnings-return relation is S-shaped (i.e. convex for bad news and concave for good news).

Cheng et al. (1992) evaluate the specification of the commonly used method of estimating the ERC, namely a linear regression of abnormal returns on unexpected earnings. They include three samples of earnings forecasts — the random walk model forecast and two sources of analyst forecasts, I/B/E/S and Value Line — and examine returns for both short (2-day) and long (more than 1 year) event windows. Testing for non-linearity, heteroscedasticity, residual non-normality, omitted variables and coefficient variation across firms, they generally reject the classical normal linear regression model assumption (i.e. in almost all cases, they find the relation to be non-linear). The Cheng et al. (1992) and Freeman and Tse (1992) studies suggest that ERC estimation models based on the linearity assumption are misspecified and may lead to inconsistent inferences. Cheng et al. replicate Cornell and Landsman (1989), and find that the specification problems are severe enough to lead to substantial instability in the linear regression model’s inferences. Their OLS analysis of Cornell and Landsman’s data revealed problems
with heteroscedasticity, non-linearity and non-normality. The model with the ranked forecast errors (the Cheng et al. approach) produced a considerably higher degree of coefficient stability, $R^2$, and larger $t$-values than the conventional, unranked forecast error approach (used by Cornell and Landsman).

In contrast with Abdel-khalik (1990), Das and Lev (1991) and Freeman and Tse (1992), who conduct cross-sectional and in-sample analyses, Beneish and Harvey (1993) conduct temporal and cross-sectional analyses, and provide fitting and predictive evidence. Their temporal and cross-sectional analyses on seven models (one linear, four non-linear and two non-parametric) suggest that linear models are inferior when using in-sample data, but not when using out-of-sample data. Providing evidence that some of the non-linear modelsoverfit the data, they suggest that temporal and cross-sectional ERC changes should be identified with a methodology that is robust to influential observations (e.g. adaptive non-parametric regression).

Mendenhall and Nichols (1988) find the ERC response to bad-news earnings to depend on the announcement's fiscal quarter. More specifically, the ERC is greater for interim than for annual (fourth quarter) reports. Their results suggest that ERC models should allow for differential responses to bad news for interim versus annual earnings announcements. However, their empirical tests are incomplete as they exclude good-news earnings [Palepu (1988)]. Additional theoretical development and empirical tests are necessary before definitive conclusions can be drawn.

Ohlson (1991a,b) and Ohlson and Shroff (1992) argue that earnings levels, deflated by the beginning-of-period price, are more appropriate than are properly deflated earnings changes as proxies for unexpected earnings when modeling rates of return. Easton and Harris (1991) and Ali and Zarowin (1992) use “long windows” (12-month returns), and provide evidence consistent with these models. Their findings suggest that long-window ERC studies should include earnings levels to appropriately estimate ERCs.17

Lev (1989), Easton et al. (1992) and Warfield and Wild (1992) show that earnings levels and stock prices are more highly correlated over long (4–10 years) windows than short ones (one quarter to 1 year). Kothari (1992) also uses long windows and examines alternative specifications of ERC estimation procedures when stock prices lead earnings. He shows that when stock prices impound information that is not reflected in the time-series of past earnings, earnings levels provide relatively more explanatory power than earnings changes (both deflated by beginning-of-period stock price), and that including earnings levels in the ERC estimation equation may lessen the ERC bias. The need for a precise expectations model is diminished when a long-window approach is used. With a longer window, the generally accepted accounting principle (GAAP) conservatism problem is less severe because what is reported in financial statements, via the realization and matching principles, is more congruent with what is impounded in share price.

In summary, while the evidence regarding whether the returns–earnings relation is non-linear is mixed, the relation is better specified with both (appropriately deflated) earnings levels and changes than with earnings changes alone. The need for a precise earnings expectations model, such as recent analyst forecasts, is less important when a long-window approach is used. Additional research is needed to ascertain the impact on ERC estimates of both the fiscal quarter and the nature of the news (i.e. whether it is good or bad).

4.4. Stock-price expectations and earnings expectations

Bandyopadhyay et al. (1993) examine whether analysts incorporate their earnings forecasts into their stock-price forecasts and if the usefulness of analysts’ earnings forecasts for their stock-price forecasts is related to the length of their joint stock price to earnings forecast horizon. They show that analysts act as if earnings forecasts are

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17 Easton and Harris introduce a multivariate analysis of earnings levels and changes: $R_e = \gamma_0 + \gamma_1 A/e_P + \gamma_2 \Delta A/e_P + \epsilon_e$ where: $R_e$: return on a share of firm $j$; $A$: annual accounting earnings per share of firm $j$ for period $t$; $P$: price per share of firm $j$ at time $t-1$; $\epsilon_e$: random error of firm $j$ at time $t$. 
important for their stock-price forecasts and that earnings are relatively more important for price in the longer term. Their finding that long-term ex ante ERCs are relatively greater than short-term ex ante ERCs is consistent with Lev (1989), Kothari and Sloan (1992), and Ohlson and Penman (1992), who show that long-term ex post ERCs are relatively greater than short-term ones. (Ex ante ERC studies relate expected returns to expected earnings; ex post ERC studies relate actual returns to actual earnings.)

There are two factors at work regarding the relation between the ERC and the length of the horizon. On the one hand, GAAP conservatism suggests a higher ERC when the joint earnings and price horizon is lengthened because cumulated reported earnings include relatively more of what is impounded in price. On the other hand, the ERC over the life of the firm ('birth to death') is 1.0. As a longer horizon is more akin to the life of the firm, the ERC may be smaller over a longer horizon (i.e. it may approach 1.0 asymptotically from above). Consistent with Lev's (1989) argument that GAAP conservatism in measuring earnings causes stock prices to lead accounting earnings, the Bandyopadhyay et al. (1993) evidence suggests that non-earnings information is relatively more important for shorter-term price estimates. However, Bandyopadhyay et al. (1993) are silent regarding the nature of the non-earnings information, and they do not say how analysts' stock-price forecasts, earnings forecasts and non-earnings forecasts relate to the capital markets' expectation of these variables.

Govindarajan (1980) uses content analysis to examine the importance given by security analysts to earnings versus cash flows when they make their recommendations. Security analysts' comments on companies in 976 reports were scrutinized using the Wall Street Transcript, and rated from one to six, according to the authors' interpretation of the commentary, as follows: (1) no mention of earnings, (2) earnings analysis is less important than cash flow analysis, (3) earnings analysis and cash flow analysis are equally important, (4) earnings analysis is more important than cash flow analysis, (5) earnings analysis only, except for mention of dividends and (6) no mention of cash flows. Security analysts attached more weight to earnings than cash flows in 86.6% of the total number of reports examined. Consistent with Bandyopadhyay et al. (1993), Govindarajan (1980) finds earnings to be an important source of analysts' recommendations. In contrast, Bouwman et al. (1987) use protocol analysis and conclude that income statements do not play a dominant role in analysts' selection of investment candidates. More specifically, the authors provided professional financial analysts with a package of financial materials that reflected the magnitude and types of information they normally review when screening prospective investments. The analysts were asked to verbalize 'whatever came to mind' during their evaluations. The authors' resulting transcripts, called protocols, served as the basis for their analyses.

In summary, capital markets research suggests that analysts incorporate their earnings forecasts into their stock-price forecasts and that their earnings forecasts are relatively more important for their stock-price forecasts in the longer term. The evidence from behavioral research regarding the importance of earnings forecasts is mixed. Little is known from either branch of research about the way in which analysts formulate their stock-price forecasts or the role of accounting and non-accounting information in this process.

5. Some directions for future research in the capital markets/earnings forecasting areas

Sections 2 to 4 discuss numerous directions for future research so this section discusses only a few such directions. Several studies have examined the relation between analysts' earnings forecasts and firm-specific factors, such as stock prices, changes in consensus earnings estimates, deviation from the consensus and forecast errors. However, with limited exceptions [Stone (1977), Fildes and Lam (1990)], the macroeconomic and industry factors asserted by analysts to be important cues to their decisions have been ignored. This appears to be a fruitful area for future research. Moreover, there has been a scarcity of research examining linkages between analysts' stock-price forecasts and other factors of interest (e.g. earnings forecasts, past stock prices, and macroeconomic and industry data).
As earnings forecasts are not ends in themselves, but are inputs into stock recommendations [Schipper (1991)], future research should explore these linkages.

A second direction for future research is to link post-earnings announcement drift with convergence of analysts’ earnings expectations. Bernard and Thomas (1990) suggest that drift is a delayed response to information. Verrecchia (1980) argues that the rapidity of stock-price adjustment to information increases as the precision of the information, as determined by the consensus judgment of investors, increases. If so, drift should be most evident when analysts’ forecasts converge slowly after earnings announcements. This issue should be addressed using individual, rather than consensus, analysts’ earnings forecasts, allowing the researcher to ascertain if the forecast is made conditional upon a particular earnings announcement.

A third direction for future research is to examine the role of analysts’ forecasts if capital markets are efficient compared with their role if capital markets are inefficient. If capital markets are informationally efficient in the conventional sense, and if the analyst is ‘the market’, forecast accuracy and market association are two sides of the same coin, and the role of analysts is rather limited. More specifically, in this case, a composite of analysts’ (and perhaps other) forecasts can proxy for the market’s (unknown) earnings expectation and examination of the analyst’s expectation formulation process is not especially informative. However, if capital markets are not efficient in the conventional sense, the role of analysts’ forecasts is much broader, provided that analysts are reasonably efficient processors of financial information and stock prices ultimately reflect fundamentals. In a return to the world of Graham et al. (1962), analyst behavior merits investigation to determine how fundamental

financial statement analysis can be used to detect mispricing. [Lev and Thiagarajan (1991), Penman (1992c), and others have recently advocated a “return to fundamentals.”] Such research should examine how (and why) analysts use (and ignore) certain financial statement data.

The manner in which analysts use/neglect earnings and non-earnings information is crucial for a better understanding of how stock prices are formulated. If capital markets are not informationally efficient, it is important to understand how analysts process earnings and non-earnings information to estimate intrinsic value, which is not necessarily impounded in stock price. Behavioral research, which has played a limited role to date in understanding how analysts formulate their expectations, is likely to play a more prominent role in the future.

6. Implications for forecasting research in other areas

In the past 15 years, forecasting literature has developed a number of themes which have been addressed by the literature surveyed in this paper. Some of these themes are: (i) the ex ante comparison of accuracy and the stability of models out-of-sample; (ii) the choice of error measure and if the particular error measure matters; (iii) the comparative analysis of method performance using comparable information sets; (iv) heuristics and biases of judgment and their incompatibility with rational expectations.

It has been shown that complex earnings forecasting models often fail in out-of-sample comparisons [Albrecht et al. (1977), Watts and Leftwich (1977), Foster (1977), Beneish and Harvey (1993)]. It is easy to over-identify a structural model using in-sample data, but simpler models have proven to be more robust in holdout periods. It appears that Ockham’s razor is valid — parsimonious models often are preferable to complex ones.

With accounting data, the choice of error measure is important, as the denominator can be close to zero or even negative [Lev and Sunder (1979), Frecka and Hopwood (1983)]. Thus, the results of parametric tests may rely heavily on outliers. In order to reduce the outlier problem, many studies deflate by stock price [Christie
(1987)], trim the sample [Foster (1986)], or use non-parametric tests [Brown and Rozell (1978)].

Earnings forecasting research has occasionally, but not often, provided comparative analyses of method performance with comparable information sets. For example, Brown et al. (1987c) provide similar findings with each of two sources of analysts’ earnings forecasts. However, the ERC literature has typically provided results conditional upon a particular assumed time-series process. Given the unfortunate aversion to replication in the social sciences (cf. the hard sciences where replication is the norm), it behooves social science researchers to provide results with multiple data sources.

The earnings forecasting literature has recently, but belatedly, begun to examine heuristics and biases of judgment, and its incompatibility with rational expectations [Affleck-Graves et al. (1990), Ali et al. (1992), DeBondt and Thaler (1990)]. This research is still in its infancy. Joint efforts by capital market researchers and behavioralists to examine these issues more thoroughly would considerably enhance our understanding of the role of analysts in the price formation process.

Earnings forecasting research appeared to be at a dead end in the late 1970s. Annual earnings were known to follow a random walk with drift process, except when annual earnings changes were extreme, and three univariate ARIMA models of the quarterly earnings time-series process were introduced. Little work has been done since the late 1970s to develop more accurate time-series models. Two events transpired in the late 1970s which provided an impetus for earnings forecasting research. First, analysts’ earnings forecast data became readily available in machine-readable form. Second, capital markets research began to look to forecasting research for proxies of the (unobservable) market earnings expectation.

Earnings forecasting research has flourished since its use of analyst expectational data and its linkage to capital markets research. Increased information availability, via analysts’ earnings estimates, and increased focus on information usage, via the capital markets, has greatly aided earnings forecasting research. Other disciplines utilizing forecast data may be able to sharpen their intellectual foci and broaden their perspectives by looking for ways to enhance information availability and information usage.

References


**Biography:** Lawrence D. BROWN’s principal research interests are in the use of financial information by capital market participants, primarily security analysts. Dr. Brown has over 50 publications in the areas of accounting, finance and forecasting, and he has presented his research at over 35 universities. His research in the topical area of this paper has been published in *The Accounting Review, Contemporary Accounting Research, International Journal of Forecasting, Journal of Accounting Research, Journal of Business Forecasting, Journal of Finance, Journal of Forecasting*, and *Journal of Portfolio Management*. He is an Associate Editor of the *International Journal of Forecasting* and *Review of Quantitative Finance and Accounting*; he serves on the editorial board of *Contemporary Accounting Research* and is a member of the Executive Committee of the Annual Conference on Financial Economics and Accounting.