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Tests of Analysts' Overreaction / Underreaction to Earnings Information as an Explanation for Anomalous Stock Price Behavior

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ABSTRACT

This study examines whether security analysts underreact or overreact to prior earnings information, and whether any such behavior could explain previously documented anomalous stock price movements. We present evidence that analysts' forecasts underreact to recent earnings. This feature of the forecasts is consistent with certain properties of the naive seasonal random walk forecast that Bernard and Thomas (1990) hypothesize underlie the well-known anomalous post-earnings-announcement drift. However, the underreactions in analysts' forecasts are at most only about half as large as necessary to explain the magnitude of the drift. We also document that the "extreme" analysts' forecasts studied by DeBondt and Thaler (1990) cannot be viewed as overreactions to earnings, and are not clearly linked to the stock price overreactions discussed in DeBondt and Thaler (1985, 1987) and Chopra, Lakonishok, and Ritter (Forthcoming). We conclude that security analysts' behavior is at best only a partial explanation for stock price underreaction to earnings, and may be unrelated to stock price overreactions.

IT HAS LONG BEEN documented that the initial stock price reaction to earnings announcements is quick (Patell and Wolfson (1984)). However, several studies have questioned whether this initial quick reaction is too large or too small. Some conclude that stock prices *underreact* to earnings announcements, and that the subsequent completion of the reaction appears in the form of a "post-earnings-announcement drift" in stock prices (see Bernard (Forthcoming) for a review of such evidence). On the other hand, DeBondt and Thaler (1987, 1990) characterize their evidence as consistent with *overre-*

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action to earnings, and suggest that corrections of such overreactions may explain the long-term reversals of extreme prior stock price changes documented by DeBondt and Thaler (1985) and Chopra, Lakonishok, and Ritter (Forthcoming).

The literature on both underreaction and overreaction includes some evidence to indicate that the anomalous stock price behavior around earnings announcements may be rooted in a failure by market participants to appreciate what current earnings imply about future earnings. Among such studies, Brennan (1991, p. 70) states that "perhaps the most severe challenge to financial theorists . . . [includes] the finding by Bernard and Thomas (1989, 1990)" that stock returns around earnings announcements can be characterized by a model in which stock prices partially reflect a naive seasonal random walk earnings expectation. That is, stock prices appear to reflect expectations of quarterly earnings that are anchored too heavily on the earnings of the corresponding quarter of the prior year, and that underreact to more recent earnings news. Consistent with this possibility, Mendenhall (1991) documents that one important group of stock market participants, Value Line analysts, appears to underreact to the most recent quarterly earnings observation when producing their forecasts.[1]

In apparent contrast to the literature that indicates underreaction to earnings, DeBondt and Thaler (1987) describe how investor "myopia" could lead to an *overemphasis* on earnings from the recent past, and DeBondt and Thaler (1990) report evidence to suggest that analysts' earnings forecasts tracked by Institutional Brokers Estimate System (IBES) are indeed "consistent with generalized overreaction." Specifically, they show that earnings changes forecasted by analysts are significantly more extreme than actual realizations, and conclude that the forecasts "are simply too extreme to be considered rational."

Mendenhall's (1991) and DeBondt and Thaler's (1990) evidence of inefficient analysts' forecasts raises the question of whether investor reliance on analysts might explain the anomalous stock price behavior described above. That is, analysts' earnings forecasts and recommendations could be an originating source of stock price underreaction or overreaction.

The purpose of this study is to examine the extent to which analysts' responses to earnings might explain the anomalous delayed stock price responses to earnings (Bernard and Thomas (1989, 1990)), or anomalous stock price overreactions (Chopra, Lakonishok, and Ritter (Forthcoming)). In that process, we reconcile the apparently disparate conclusions in the literature about whether analysts' forecasts underreact or overreact to earnings.

We begin by focusing on analysts' forecasts as a possible source of delayed stock price responses to earnings. We show that analysts' forecasts share

[1] Other papers also document underreaction of analysts' forecasts to the most recent analyst forecast error (i.e., positive first-order autocorrelation in analysts' forecast errors). For example, see Ali, Klein, and Rosenfeld (1992). Lys and Sohn (1990), Klein (1990), and Abarbanell (1991) document analyst underreaction to prior period stock price behavior. See Schipper (1991) for a review of this and other work on analysts' forecasts.

some of the key properties of the naive (seasonal random walk) earnings expectations that are consistent with the stock price behavior documented by Bernard and Thomas (1990). Specifically, Value Line analysts' quarterly earnings forecast errors are positively autocorrelated over the first three lags, with declining magnitude, which is consistent with the form of underreaction to recent earnings exhibited by a seasonal random walk model. However, we find no reliable evidence of an overemphasis in Value Line forecasts on the earnings of the corresponding quarter of the prior year, as occurs in a seasonal random walk. Moreover, we find that the magnitude of the autocorrelations in analysts' forecast errors are at most about half as large as necessary to explain the magnitude of the delayed stock price response to earnings. The implication is that, while the anomalous underreaction of stock prices to earnings information may be *partially* rooted in whatever causes inefficiencies in analysts' forecasts, a full understanding of the anomaly must involve other factors as well.

We turn next to the issue of stock price overreaction, and the related question of how one can reconcile the apparent conflict between the analyst underreaction discussed above and the analyst overreaction documented by DeBondt and Thaler. We show that even if the "extreme" analysts' forecasts in DeBondt and Thaler (1990) are labeled as "overreactions," they cannot be viewed as overreactions to earnings.[2] Moreover, we find no clear linkage between these extreme forecasts and the stock price overreactions discussed in DeBondt and Thaler (1985, 1987) and Chopra, Lakonishok, and Ritter [Forthcoming].

The remainder of this study is organized as follows. Section I includes a discussion of some of the literature that provides the background for this study. Data used in the empirical tests are described in Section II. In Section III we examine whether analysts' forecasts conform to the "naive" earnings expectations that would explain the stock price behavior in Bernard and Thomas (1990). Having established at least some degree of underreaction in analysts' forecasts, we then examine in Section IV whether it is sufficiently large to "explain" the magnitude of the delayed stock price response to earnings. In Section V, we reconcile the evidence on analyst underreaction to earnings with the DeBondt and Thaler evidence on the overreaction hypothesis. Section VI contains tests of whether the analyst overreaction detected by DeBondt and Thaler (1990) can be linked to stock price overreaction. Finally, concluding remarks are offered in Section VII.

I. Backdrop for the Study

A. Evidence Suggesting Stock Price Underreaction to Earnings

More than twenty (nonindependent) studies have documented what appears to be a lagged response to quarterly earnings, labeled post-earnings-

[2] In research conducted concurrently with this study, DeBondt (1991) draws a similar conclusion.

announcement drift (e.g., Jones and Litzenberger (1970), Joy, Litzenberger, and McEnally (1977), Rendleman, Jones, and Latane (1982), Foster, Olsen, and Shevlin (1984)). Repeated attempts to explain post-earnings-announcement drift as the product of research design flaws, including a failure to control fully for risk, have failed to resolve the anomaly (e.g., Bernard and Thomas (1989)).

Given the failure to explain post-earnings-announcement drift through conventional means, several recent studies have turned to the possibility that (for reasons not fully understood) investors fail to appreciate the extent to which changes in current quarterly earnings signal future changes in earnings. This possibility was first raised and tested in Rendleman, Jones, and Latane (1987), Bernard and Thomas (1989), and Freeman and Tse (1989). Bernard and Thomas (1990) and Wiggins (1991) sharpen the depiction of the kind of earnings expectations that could explain the data, and extend the prior work in a way that rules out several alternative interpretations of the evidence.

The essential hypothesis tested in Bernard and Thomas (1990) and Wiggins (1991) is that stock prices reflect, at least partially, a naive earnings expectation: one based on a seasonal random walk, where expected earnings are simply earnings for the corresponding quarter from the previous year. Given the way quarterly earnings actually behave (and have behaved since at least the 1940s; see Bernard (Forthcoming) for a summary), such naive forecasts would tend to err in a predictable way. Specifically, the forecast errors would be positively autocorrelated (in declining magnitude) at the first three lags, and negatively autocorrelated at the fourth lag.

The results of both Bernard and Thomas (1990) and Wiggins (1991) are consistent with stock prices being at least *partially* influenced by earnings expectations that are naive in the sense described above. That is, both studies show that the three-day stock price reactions to earnings announcements for quarters $t + 1$ through $t + 4$ are predictable, based on earnings of quarter t. Moreover, the signs and magnitudes of the predictable reactions conform to the signs and magnitudes of the autocorrelation in seasonal-random-walk forecast errors, as if market expectations fail to deviate sufficiently from a seasonal random walk. The reactions for quarters $t + 1$ through $t + 3$ are consistent with an initial *underreaction* to earnings, and a subsequent delayed response in the same direction. The reaction at the announcement for quarter $t + 4$ is more readily characterized as a reversal of a prior *overreaction*. However, this latter effect is small, relative to the stock price movement over the prior three quarters, and thus the overall stock price behavior is most consistent with initial underreaction to earnings.

Although the evidence in both Bernard and Thomas (1990) and Wiggins (1991) is consistent with market participants maintaining earnings expectations that are "too close" to a naive seasonal random walk, neither investigates directly whether the forecasts of any market players behave accordingly. Mendenhall (1991) shows that Value Line analysts' forecasts are

positively autocorrelated at the first lag, which is consistent with *one* of the features of an expectation that fails to deviate sufficiently from a seasonal random walk. Sections III and IV will provide evidence on whether higher-order autocorrelations in Value Line analysts' forecasts are also consistent with such expectations, and whether the autocorrelations in analysts' forecast errors are large enough to explain post-earnings-announcement drift.

B. Evidence Suggesting Stock Price Overreaction to Earnings

DeBondt and Thaler (1985, 1987) document long-run reversals of prior stock price changes, which they interpret as corrections of prior overreactions to news events. They show that a strategy of buying prior extreme "losers" and selling prior extreme "winners" (measured in terms of stock price performance) generates positive market-adjusted returns of approximately 12% per year over the next three years. Ball and Kothari (1989) suggest that when one controls for nonstationary betas, the market-adjusted returns can be explained as risk premia. However, Chopra, Lakonishok, and Ritter (Forthcoming) argue that Ball and Kothari overstate the influence of the beta adjustment, by assuming that market price of risk is as implied by the Sharpe-Lintner CAPM. When they rely instead on an empirical estimate of the market price of risk, the DeBondt-Thaler portfolios generate abnormal returns of approximately 5% per year, even after controlling for nonstationary betas and the size effect.

Assuming that overreactions sometimes occur in the stock market, there is still the question of what is driving the overreactions. DeBondt and Thaler (1987) suggest that stock market participants may overreact to current earnings, not recognizing that extreme annual earnings changes tend to be partially reversed in the future (Brooks and Buckmaster (1976), Freeman, Ohlson, and Penman (1982)). Consistent with this possibility, DeBondt and Thaler (1990) show that forecasted changes in earnings tend to be too extreme, relative to ultimate realizations of earnings changes. They conclude that the evidence documents analyst overreaction, although they do not link that overreaction directly to the stock price overreaction in prior studies.

Klein (1990) also tests for overreaction in analysts' forecasts. She shows that analysts' annual earnings forecasts are too optimistic for firms with large prior stock price declines, which seems consistent with underreaction (to the price decline), not the overreaction that DeBondt and Thaler find. The apparent inconsistency between Klein's evidence (or that in Section I.*A* on underreaction in analysts' forecasts) and the findings of DeBondt and Thaler (1990) have yet to be addressed.

The question of how one can reconcile the apparently inconsistent evidence on analyst overreaction and underreaction, as well as the question of which characterization is more appropriate, is addressed in Section V. The linkage between analyst overreaction and stock price overreaction is examined in Section VI.

II. Sample Selection and Data

Data used in this study include primary earnings per share (EPS) and corresponding Value Line forecasts, as well as stock price data, for 178 firms and up to 44 quarters, spanning the period 1976 through 1986. Value Line forecasts are preferred in this context to consensus forecasts, like those available from IBES and used by DeBondt and Thaler (1990) and Klein (1990). To the extent consensus forecasts include individual forecasts that are not up to date, there is an artificially-induced correlation between consecutive forecast errors that would take on the appearance of an underreaction or an overreaction, depending on the research design.[3]

Firms qualifying for inclusion in our sample were those that appeared on the Compustat and CRSP data files, and which were included in the Value Line index as of 1985. From this population, we selected at random 100 firms that were above the median Compustat firm in terms of market value of equity in 1986, and 100 firms that were below this median. The process was designed to allow sample partitions based on firm size, because the magnitude of the previously discussed earnings-related anomalies varies according to firm size (Foster, Olsen, and Shevlin (1984), Bernard and Thomas (1989, 1990)). Based on their size relative to the overall NYSE/AMEX population, and roughly consistent with the classifications in Bernard and Thomas (1989, 1990), we label the firms above the median as "large firms," and those below the median as "medium-sized firms." It turns out that while the magnitudes of some of the relations studied here vary by firm size, the primary conclusions of the study do not. Therefore, differences in the results across firm size categories are discussed only when they are significant.

From the 100 large and 100 medium firms originally identified, there were 178 for which at least 16 consecutive observations of Value Line forecasts, EPS, and stock price data (from CRSP) were available within the 1976–1986 period. This set of 178 firms constitutes the sample used in the analysis. The mean number of observations per firm is 36; the median number is 40.

Although earnings per share (EPS) data are available from Compustat, we derived EPS data from Value Line to assure that forecasted EPS is matched with the appropriate realized EPS figure. All data were retroactively adjusted for stock splits and stock dividends, to assure comparability through time. Throughout the analysis, earnings-based variables that lie in the upper or lower 1% of the distribution were winsorized to mitigate the influence of any extreme observations.

Our sample selection procedures introduce some survivorship bias, but Bernard and Thomas (1989) show that survivorship bias has little or no affect on post-earnings-announcement drift. Ball and Kothari (1989) argue

[3] In a test based on autocorrelations in forecast errors, the presence of out-of-date forecasts in the consensus would induce positive autocorrelation, thus giving the appearance of underreaction. In a test like that used by DeBondt and Thaler (1990) and described in Section V of this paper, such out-of-date forecasts would give the appearance of what DeBondt and Thaler label an overreaction.

that survivorship bias should have little influence on tests for stock price overreactions.

III. Empirical Tests: Do Analysts' Forecast Errors Share the Properties of a Naive Seasonal Random Walk Expectation?

Here we examine whether analysts' forecasts share the properties of "naive" (seasonal random walk) earnings expectations consistent with the stock price behavior in Bernard and Thomas (1990) and Wiggins (1991). To provide a basis for comparison, we first examine the behavior of mechanical forecasts that are based *strictly* on a seasonal random walk, that is, where the forecast is simply equal to the earnings of the corresponding quarter of the prior year. Table I, Panel A indicates that on average in our sample, such forecast errors are positively autocorrelated at the first three lags, with declining magnitude: 0.42, 0.25, and 0.10, respectively. At the fourth lag, the mean autocorrelation is negative (−0.20). This same pattern has been shown to hold across

Table I

Autocorrelations in Seasonal Random Walk Forecast Errors and Value Line Forecast Errors 178 Firms; 1976–1986

Panel A: Autocorrelation in Seasonal Random Walk Forecast Errors

Lag	1	2	3	4
Mean	0.42	0.25	0.10	−0.20
Median	0.44	0.23	0.08	−0.21

For each firm in sample, quarterly EPS is seasonally differenced (adjusting for stock splits, where necessary) to generate the data series underlying the autocorrelations reported above. Number of observations per firm ranges from 16 to 44, with a median of 40, before seasonal differencing.

Panel B: Autocorrelation in Value Line Quarterly Forecast Errors

	Autocorrelations at Lag			
Estimation Procedure	1	2	3	4
Firm-specific estimates				
Mean	0.12	0.06	0.03	0.02
(*t*-statistic)	(8.20)	(3.69)	(1.80)	(1.30)
Median	0.10	0.05	0.01	−0.01
Pooled estimates				
Autocorrelation	0.20	0.15	0.10	0.10
(*t*-statistic)	(15.77)	(11.84)	(7.58)	(7.47)

For each firm in sample, quarterly EPS less the most recent Value Line EPS forecast (adjusted for stock splits, where necessary) constitute the data series underling the autocorrelations reported above. Number of observations per firm is same as in Panel A. Pooled estimates of the autocorrelations are estimated by correlating (in pooled cross-section) quarterly forecast errors with lagged forecast errors.

different time periods and, perhaps surprisingly, the pattern is quite consistent across industries (Bernard and Thomas (1990), Bernard (Forthcoming)).

Table I, Panel B presents autocorrelations in Value Line analysts' forecast errors. At the top of the panel, we report means and medians of firm-specific autocorrelations, which can be compared to the means and medians based on the seasonal random walk forecasts in Panel A. At the first three lags, we obtain estimates that conform to the same pattern as those in Panel A, but are only 20–40% as large: 0.12, 0.06, and 0.03, respectively.[4] These estimates suggest that Value Line analysts produce forecasts that are less naive than a simple seasonal random walk, but still fail to recognize the full extent to which earnings deviate from that process. The medians for the first three lags (0.10, 0.05, and 0.01) are smaller, but also conform to the pattern documented in Panel A.[5]

The major discrepancy between the analysts' forecasts and those based on a seasonal random walk appears in the autocorrelation at the fourth lag. Whereas a seasonal random walk forecast would produce a negative autocorrelation at that lag, for the analysts' forecasts we observe an insignificantly positive mean estimate (0.02) and a small negative median estimate (-0.01). Thus, while the analyst data are consistent with underreaction to the three most recent earnings numbers, we find no indications of an overreliance on the earnings of the corresponding quarter of the prior year.

The estimated autocorrelations in analysts' forecast errors described thus far could possibly be biased downward. The reason is that firm-specific autocorrelations are calculated based on deviations around a firm-specific mean forecast error that is known only ex post. In contrast, autocorrelations calculated in a pooled dataset can be based on deviations around a sample-wide mean forecast error, and would not assume foreknowledge of the firm-specific means. If there is any stability through time in the distribution of firm-specific mean forecast errors, pooled estimates of autocorrelations will be higher than the average of firm-specific estimates.

The second row of estimated autocorrelations in Table I, Panel B is based on the pooled dataset, and the estimates are indeed higher: 0.20, 0.15, 0.10, and 0.10, respectively. Once again, the estimates for the first three lags suggest that while Value Line analysts do not completely ignore recent

[4] The standard errors underlying the t-statistics in Table I, Panel B should be interpreted cautiously, given that the assumption of independence across firms is almost certainly violated (see Bernard (1987)). Cross-sectional dependence is of concern here and in the other tables that use earnings data (e.g., earnings forecast errors) as dependent variables, largely because all firms are affected by economy-wide movements. However, given the limited number of time series observations available here, relative to the number of firms, standard techniques for adjusting for cross-sectional dependence are not feasible.

[5] A potential explanation for a positive autocorrelation at the first lag is that analysts' forecasts may sometimes be published soon after the previous earnings announcement, in which case the forecast might have been *produced* prior to the announcement. However, when we restrict attention to only those forecasts published more than 10 days after the prior announcement, our results are essentially unchanged.

earnings information, as a seasonal random walk forecast does, they nevertheless appear to be underreacting to that information. In fact, the pooled estimates suggest significant underreaction even to the four-quarter-old earnings information (in contrast to the behavior of a seasonal random walk forecast).[6]

To gauge the economic significance of the autocorrelation in analysts' forecast errors, consider a firm with forecasted quarterly earnings per share in the range of \$1.00. The mean Value Line analysts' forecast error in our sample is (in absolute terms) 27% of the forecasted value. A first-order autocorrelation of 0.20 in the analysts' forecast errors thus implies a predictable error of approximately \$0.05 in this example (\$1.00 $\times$ 27% $\times$ 20%).

When the analysis is repeated for large and medium-sized firms (not reported in table), we find the same general pattern for both, but there is more autocorrelation in seasonally differenced earnings for large firms at the first three lags. (The autocorrelations are about 30% larger at each lag.) The higher degree of autocorrelation also translates to the analysts' forecast errors.

In summary, consistent with a forecast that does not deviate sufficiently from a seasonal random walk, the Value Line forecasts produce errors that are positively autocorrelated over the first three lags, in declining magnitude. Such evidence is consistent with analysts underreacting to recent earnings reports. In contrast to the seasonal random walk model, however, there is no reliable indication of a negative autocorrelation at the fourth lag, which would have indicated overemphasis on the earnings of the corresponding quarter of the prior year. Thus, while analysts' forecasts share some of the properties of the naive expectations that Bernard and Thomas (1990) indicate are embedded in stock prices, the commonality exists only where the naive expectations reflect underreaction.

IV. Systematic Errors in Analysts' Forecasts as an Explanation for Anomalous Stock Price Behavior after Earnings Announcements

We now examine the extent to which the predictable errors in analysts' forecasts described above are sufficient to "explain" post-earnings-announce-

[6] Our estimates of first-order autocorrelations can be compared to those previously reported in the literature. The median firm-specific autocorrelation at the first lag (0.10) is close to the amounts reported by Givoly (1985) and Mendenhall (1991). The pooled first-order autocorrelation (0.20) is somewhat lower than the 0.28 reported by Mendenhall. However, when we restrict attention to the large firms in our sample, which would be more comparable to those in the Mendenhall sample, we obtain an estimate of 0.25. If in addition, we use Mendenhall's approach of calculating forecast errors by subtracting forecasts per Value Line from earnings per Compustat (as opposed to using Value Line data throughout), the estimate rises to 0.31. Another difference between our approach and that of Mendenhall lies in how the data are scaled, but this difference has very little impact on our results.

ment drift. That is, if Value Line forecasts perfectly mirrored the earnings expectations embedded in stock prices, would post-earnings-announcement drift be as large as it is and behave as it does?

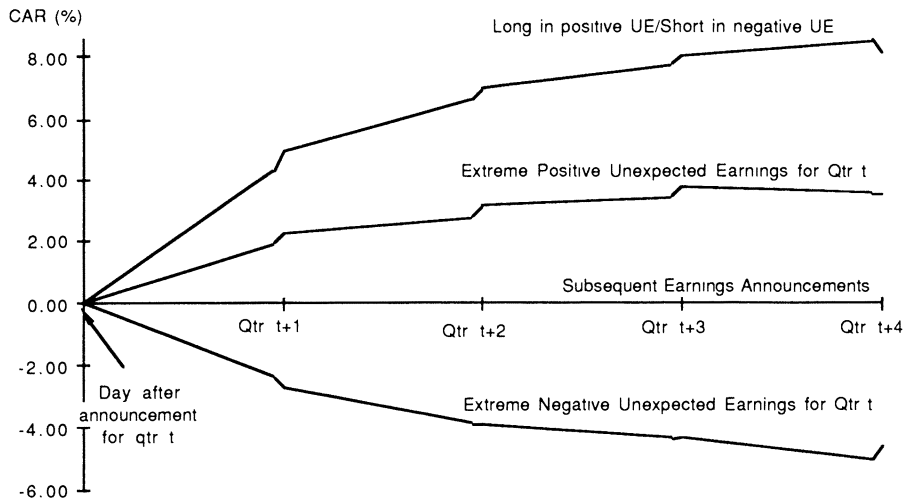
Figure 1 graphically depicts the magnitude of post-earnings-announcement drift in our sample. We group firms into quintiles based on the magnitude of analysts' earnings forecast errors (scaled by stock price 10 days prior to the forecast date) within that quarter.[7] We then calculate cumulative abnormal (size-adjusted) returns (CARs) beginning the day after the earnings announcement, and extending through the fourth subsequent announcement.[8] For a combined long position in firms within the highest quintile of unexpected earnings and short position in the lowest quintile, the total post-earnings-announcement CAR is about 8%.

The 8% cumulative abnormal return is within the range of the amounts reported by Bernard and Thomas (1989, 1990) for large and medium-sized firms (4% and 10%, respectively), which is the size classification our sample assumes relative to the Bernard-Thomas sample. Although it is not shown in the figure, the four-quarter post-earnings-announcement abnormal return in our sample is about 1.5% larger for the medium-sized firms than the large firms. Note that the greater post-announcement drift for medium-sized firms cannot be explained as a reflection of greater underreaction by analysts for those firms; we previously reported slightly more underreaction by analysts for the large firms. Thus, at least one aspect of the anomalous post-earnings-announcement drift cannot be attributed to the behavior of analysts.

The concentration of the post-earnings-announcement abnormal returns around subsequent earnings announcements confirms that the main result observed in Bernard and Thomas (1990) holds in our much smaller sample, and when unexpected earnings is defined relative to analysts' forecasts, as opposed to a statistical forecast. The returns are consistent with the notion that market expectations partially reflect the properties of a seasonal random walk, and thus the market is consistently "surprised" to find that after good (bad) news is revealed in quarter t, earnings tend to rise (fall) again (relative to the prior year) in quarters $t + 1$, $t + 2$, and $t + 3$, and then assume a level in quarter $t + 4$ that is less extreme than the quarter t level. The magnitudes of the three-day returns in our sample for quarters $t + 1$ and $t + 2$ are

[7] It is not possible to know the quintile assignment with certainty at the time a firm's earnings are announced, since not all other firms in the distribution have already announced their earnings. Thus, this procedure introduces some hindsight bias discussed first by Holthausen (1983). However, Bernard and Thomas (1989) found that in a sample for which our sample represents a subset, this hindsight bias had little or no effect on post-earnings-announcement drift.

[8] The abnormal returns are calculated by subtracting from each firms' daily return, the equally-weighted return on a control portfolio of all firms within the same NYSE/AMEX size decile as of the beginning of the calendar year. This daily abnormal return is then summed over time to compute a cumulative abnormal return (CAR). The measure is the same as that used in Bernard and Thomas (1989, 1990), which in turn is based on the methods used in Foster, Olsen, and Shevlin (1984). Bernard and Thomas (1989) show that the behavior of post-earnings-announcement drift is largely insensitive to adjustments for systematic and other risks, and compounding rather than summing returns.



Unexpected earnings quintile:	CAR over four quarters subsequent to earnings announcement:								
	Qtr t+1:		Qtr t+2:		Qtr t+3:		Qtr t+4:		Total CAR:
	Prior to ann:	3-day ann:	Prior to ann:	3-day ann:	Prior to ann:	3-day ann:	Prior to ann:	3-day ann:	
Highest quintile:	1.91	.35	.52	.35	.29	.32	-.24	-.03	3.47
Lowest quintile:	-2.38	-.34	-1.17	0.00	-.48	.06	-.78	.44	-4.65
Long in highest/ short in lowest	4.29	.69	1.69	.35	.77	.26	.54	-.47	8.12
t-statistic:	(6.67)	(3.10)	(2.66)	(1.45)	(1.17)	(1.08)	(.82)	(-1.89)	(5.86)
Comparable CAR (t-statistic) from Bernard-Thomas (1990)	4.37	1.32 (14.63)	1.09	.70 (8.46)	.58	.04 (0.45)	-.95	-.66 (-7.86)	7.59

Figure 1. Post-earnings-announcement drift for extreme analyst forecast error portfolios 178 firms; 1976–1986. Firms are ranked within quarters on Value Line EPS forecast errors, scaled by stock price ten days prior to forecast. Cumulative abnormal (size-adjusted) returns are plotted above for firms in top and bottom quintile of this distribution, and for the portfolio including a long position in the top quintile and a short position in the bottom quintile. Time between subsequent announcements varies by firm-quarter, but is held constant in graph for sake of clarity.

only about half as large as those for Bernard and Thomas' full sample (see bottom row of Figure 1), but are similar to those for Bernard and Thomas' large firms. A possible explanation is that the subset of medium firms that generate enough investor interest to merit a following by Value Line and therefore qualify for inclusion in our sample have stock price behavior around the subsequent announcements that is more like that of large firms.[9]

[9] Supplemental tests demonstrate that the difference is not explained by our use of analysts' forecasts, as opposed to Bernard's and Thomas's use of statistical forecasts.

Earlier, we found no indication of negative autocorrelation at the fourth lag in Value Line analysts' forecast errors, and thus the analysts' behavior clearly provides no explanation for the negative market reaction upon the quarter $t + 4$ announcement for the combined portfolio in Figure 1. However, we now consider whether analyst underreaction to recent earnings information is large enough to "explain" the much larger positive abnormal returns that arise over the first three quarters following the initial earnings announcement.

A. *Do Stock Prices Underreact to Earnings More or Less than Analysts' Forecasts?*

We begin by writing the abnormal stock return over quarter t (CAR_t) as a function of unexpected earnings (UE_t) and an error term, e_t:

$$CAR_t = a + b\,UE_t + e_t \tag{1}$$

In equation (1), the term UE_t represents unexpected earnings from the perspective of the market, and we allow for the possibility that market expectations do not impound all available information, so that some portion of UE_t is predictable.

Now consider the implications of assuming that the market expectations underlying the calculation of UE_t are captured precisely by Value Line analysts' forecasts. Based on the observed positive but declining autocorrelation in analysts' forecast errors documented earlier, we write UE_t below as a simple autoregressive process:

$$U_t = \delta + \phi UE_{t-1} + v_t \tag{2}$$

Supplemental analyses show that results based on a second-order or third-order autoregressive process yield similar conclusions.[10] Under the assumption in equation (2), the abnormal return for quarter t can be decomposed as shown below, into a component $b\phi UE_{t-1}$ that is predictable as of the beginning of the period and an unpredictable shock bv_t. The first of these components constitutes post-earnings-announcement drift:

$$CAR_t = a + b\delta + b\phi UE_{t-1} + bv_t + e_t \tag{3}$$

The framework for the empirical test is now in place. We estimate a regression model based on equation (3):

$$CAR_t = \lambda_0 + \lambda_1 UE_{t-1} + \lambda_2 v_t + \varepsilon_t \tag{4}$$

[10] If UE_t followed a first-order autoregressive process, the autocorrelations in the series would dampen somewhat more quickly than they do in Table I, Panel B, and the error term in equation (2) would be white noise. In fact, the residual autocorrelations over the first four lags indicate some mild departures from white noise: -0.02; 0.07; 0.03; and 0.05. See footnotes 14 and 17 for discussion of results based on higher-order autoregressive processes.

Under the assumption that underreaction in market expectations is equivalent to that in Value Line forecasts, the ratio of λ_1 to λ_2 would be equal to ϕ, which is the ratio of the corresponding parameters ($b\phi$ and b) in (3) and is determined by the autoregressive parameter describing analysts' forecast errors, as specified in equation (2). Note that this condition should hold at least approximately, even if there is some measurement error in our proxies for unexpected earnings that induces bias in λ_1 and λ_2. The reason is that the forecast error for each quarter gives rise to two data points—one being v_t and one the subsequent observation of UE_{t-1}—and approximately 96% of the variance $[1 - \text{corr}(UE_t, UE_{t-1})^2]$ in these two data points is shared. Thus, if there is measurement error in v_t that induces downward bias in the estimate of λ_2, then there must also be measurement error in the subsequent observation of UE_{t-1} that induces approximately the same amount of downward bias in the estimate of λ_1.[11]

The test of the constraint that λ_1/λ_2 equals ϕ is summarized in Table II, Panel A. When UE_t is measured as the Value Line forecast error (scaled by the price prior to the forecast date and expressed in terms of percentiles within quarters[12]), the estimate of ϕ is 0.18, which is, as expected, similar to the pooled estimate (.20) of the first-order autocorrelation in forecast errors reported in Table I, Panel B.[13] The ratio of λ_1 to λ_2 is 0.80—more than four times greater than ϕ. An F-test easily rejects the null hypothesis that the data fit the implied constraint; the F-value is 41.72, which exceeds the 6.63 critical value for significance at the .01 level.[14]

The analysis indicates that the response to lagged earnings in equation (4)

[11] Measurement error in unexpected earnings can derive from either incorrect expectations or some price-irrelevant component of earnings itself. Since the same expectation (Value Line forecast) underlies both v_t and the subsequent observation of UE_{t-1}, expectations cannot induce differential measurement errors in the two variables. It is conceivable that price-irrelevant earnings components could explain a different amount of the variance in v_t than in the subsequent observation of UE_{t-1}; for example, if such measurement error were highly correlated through time, it would be nearly purged from v_t but still present in the subsequent observation of UE_{t-1}. This would bias the estimated ratio of λ_1/λ_2 downward. While we are aware of such possibilities, we have no reason to suspect that our estimated ratios contain a bias in either direction.

[12] By transforming the variables in this way, we reduce the degree of non-linearity in the returns-earnings relation induced by extreme observations. For evidence on the non-linearity, see Beaver, Clarke, and Wright (1979), Bernard and Thomas (1989), or Cheng, Hopwood, and McKeown (Forthcoming).

[13] The estimate is not exactly equal to that in Table I, because as noted above, the values of unexpected earnings have been expressed here in terms of percentiles.

[14] An analogous approach that allows for a second-order or third-order autoregressive structure in equation (2) yields essentially the same conclusions. Moreover, this analogous approach provides a comparison of the two-quarter-old and three-quarter-old lag in the response of analysts and stock prices to earnings that is entirely consistent with the results reported here for the one-quarter-old lag. Specifically, the ratio of the lagged to the contemporaneous stock price response is greater than would be predicted on the basis of the autocorrelations in forecast errors, by a factor of nearly five for the first quarter subsequent to the earnings announcement, and a factor of 2.5 for the second and third quarters.

Table II

Test of Stock Price Underreaction to Earnings, Relative to Analyst Underreaction to Earnings

Description of autoregressive structure of analyst forecast errors:

$$UE_t = \delta + \phi UE_{t-1} + \upsilon_t. \tag{2}$$

Regression of abnormal returns against predictable and unpredictable component of analyst forecast error:

$$CAR_t = \lambda_0 + \lambda_1 UE_{t-1} + \lambda_2 \upsilon_t + \varepsilon_t. \tag{4}$$

Under the assumption that underreaction in stock prices is equivalent to that in Value Line forecasts, then $\lambda_1/\lambda_2 = \phi$.

Panel A: A Test for Full Sample

Equation	R^2	Parameter	Parameter estimate	t-statistic:
(2)	0.034	ϕ	0.184	14.64
(4)	0.047	λ_1	0.064	9.97
		λ_2	0.080	12.19

F-test of restriction in equation (4) that $\lambda_1/\lambda_2 = \phi$: 56.86 (significant at 0.01 level)

Panel B: Tests for Subsamples with Varying Value Line Forecast Horizons

Timing of Forecast (Number of Days Prior to Earnings Announcement)	λ_1 (Lagged Response)	λ_2 (Contemporaneous Response)	λ_1/λ_2 (Ratio of Lagged to Contemp)	ϕ (Autocorrelation in f'Cast Errors)	F-test of $\lambda_1/\lambda_2 = \phi$*
Early (> 44 days)	0.039	0.085	0.45	0.19	2.99
33 to 44 days	0.080	0.108	0.74	0.17	23.35
15 to 32 days	0.089	0.078	1.14	0.19	30.62
Late (< 15 days)	0.055	0.044	1.25	0.18	9.97
Full sample	0.064	0.080	0.80	0.18	56.86

CAR_t is cumulative abnormal (size-adjusted) return for period ranging from day after previous earnings announcement through earnings announcement for quarter t. UE_t is Value Line analyst forecast error, scaled by stock price ten days prior to forecast date. UE_t is ranked in terms of percentiles within quarters and scaled to range from zero to one, so as to mitigate nonlinearities induced by extreme observations.

* Critical value is 3.84 for .05 level of significance; 2.70 for 0.10 level of significance.

is much larger, relative to the contemporaneous response, than would be the case if the earnings expectations embedded in stock prices mimicked the Value Line analysts' forecasts. This suggests that, although Value Line analysts appear to underreact to recent earnings information, stock prices appear to underreact to an even greater degree. This finding, as well as the earlier finding of a negative association between unexpected earnings for quarter t and the stock price reaction to the earnings announcement for

quarter $t + 4$, suggests that expectations embedded in stock prices more closely resemble naive seasonal random walk forecasts than do Value Line analysts' forecasts. (This suggestion is examined more closely below.)

This evidence complements that of Mendenhall (1991), who showed that analysts' forecast revisions can be used to predict a statistically significant portion of the reaction to the subsequent earnings announcement. Mendenhall's evidence indicates that, at least to some extent, stock prices reflect less information than analysts' forecasts. The test in this section calibrates the magnitude of the difference in information reflected in stock prices and analysts' forecasts, and suggests that an important portion of post-earnings-announcement drift must be explained by looking to factors beyond analysts' behavior.

B. Sensitivity of Test Results to Value Line Forecast Horizon

There is the possibility of a bias in favor of the finding of a larger lagged response in stock prices than analysts' forecasts. Whereas the lagged response of stock prices to earnings is measured beginning the day after the prior announcement, analysts typically do not reveal their response in the form of a new earnings forecast so quickly. The delay in releasing updated forecasts could provide the analysts with an "advantage" relative to stock prices in the above tests. This would be the case if forecasts released later in the quarter impounded the prior earnings information more completely, and thus contained errors that exhibited less autocorrelation.

A test for this source of bias appears in Table II, Panel B. Here, the sample is divided into quartiles, depending on the number of days between the Value Line forecast and the subsequent earnings announcement. For a given firm, this number is relatively consistent over time. Perhaps surprisingly, there is no indication that a delay in releasing the forecast translates into an advantage for the Value Line analyst, in the sense of reducing autocorrelation in forecast errors. The level of first-order autocorrelation, which is 0.18 for the overall sample, lies between 0.17 and 0.19 for each of the quartiles. The key implication is that the previously discussed test is not biased in favor of the observed finding.

Even though the autocorrelations in analysts' forecasts are approximately invariant to the timing of the forecast, the ratio of the lagged stock price response to the contemporaneous stock price response is much larger for forecasts that are issued later in the quarter. In fact, the ratio is nearly three times larger—1.25 versus 0.45—when the Value Line forecast is made within 15 trading days of the next earnings announcement, than when it is made more than 44 days prior to the announcement. The evidence indicates that the contemporaneous response to the forecast error is smaller (and the lagged response is relatively larger) when the information in the forecast error becomes available closer to the earnings announcement. This result is consistent with a market that can process only a given amount of earnings

information per unit time, where time refers to weeks or months.[15, 16] Such behavior could not have been predicted on the basis of prior research, but it is consistent with the well-documented post-earnings-announcement drift.

The finding that the ratio of lagged to contemporaneous stock price response to earnings forecast errors depends on the timing of the forecast raises questions about which forecast horizon supplies the most appropriate comparison between that ratio and the autocorrelation in analysts' forecast errors. Since the response of stock prices to earnings information varies according to the "age" of the information, it is informative to hold that age constant across stock prices and analysts. The ratio for the sample of forecasts published early in the quarter comes closest to meeting that condition. For that sample, the forecast date (at which time the analyst's response to prior earnings is measured) and the earnings announcement date (at which time the stock market's response to prior earnings is measured) are close, and the new information reflected in the prior forecast error ranges from zero to three months old for both.

For the sample of forecasts published early in the quarter, the ratio of lagged to contemporaneous stock price response is 0.45. Comparing that ratio to the autocorrelation in analysts' forecast errors (0.19), we find that the lagged response of stock prices is slightly more than two times as large as it would be if such prices reflected the analysts' earnings expectations.[17]

To gauge the economic significance of post-earnings-announcement drift and the portion that could be explainable based on analysts' underreaction,

[15] If stock prices responded immediately to the information in forecast errors, then the lagged response would always be zero. Given that our return interval always begins before *any* of the forecasts, the contemporaneous response coefficient should be invariant to the timing of the forecast. Of course, the contemporaneous *correlation* between returns and forecast errors *should* be sensitive to forecast timing; the errors of the later forecasts will tend to capture less of the information becoming available over the return interval and thus explain less of the variation in returns. For such late forecasts, much of the returns from the early portion of the quarter may be unrelated to the forecast error, but if so, the early returns should simply translate to the residual and leave the coefficient unaffected. In other words, although the variance of the later forecast errors may be smaller, the response *per unit of forecast error*—that is, the *coefficient*—should not depend on whether the forecast error becomes known over the entire quarter, or only within the last few days. It is for this reason that even relative "staleness" in the later forecasts present no difficulty.

[16] One unexpected feature of the results is that *both* the contemporaneous *and* lagged response to earnings forecast errors are smaller when the forecast occurs just prior to the earnings announcement. One possible explanation is that the uncertainty remaining about earnings in the last few days before the announcement is relatively more affected by accounting adjustments that have little influence on expected future earnings, and thus generate little stock price response.

[17] The analogous tests that allow for a third-order autoregressive process in earnings forecast errors were also applied within the subsample of earnings forecasts issued early in the quarter. The results suggest a delayed stock price response that is approximately 2.5 times as large as would be expected if stock prices reflected analysts' earnings expectations, in both the first and second quarter subsequent to the earnings announcement. For the third subsequent quarter, both the delayed stock price response and the delayed analyst response were small and statistically insignificant.

recall that for our sample, the drift for extreme good news (bad news) firms is approximately 3.5% (−4.7%) over the course of the following year. If this amount is about twice as large as would be expected if stock prices reflected analysts' earnings expectations precisely, then drift of approximately 2% per position might be explainable as a function of analysts' underreaction.

C. Comparison of Market Earnings Expectations with Seasonal Random Walk Forecasts

The above analysis indicates that stock prices respond to earnings information more sluggishly than do Value Line analysts. An open question is whether the stock price response could be so sluggish as to mimick the seasonal random walk forecast, which completely ignores the autocorrelation structure of year-to-year changes in quarterly earnings. Note that while Bernard and Thomas (1990) found that stock prices fail to reflect the full extent to which earnings deviate from a seasonal random walk, they did not go so far as to claim stock prices completely ignore such deviations.

To address this issue, the analysis described above is repeated while substituting seasonal random walk forecasts for analysts' forecasts. When (consistent with the above approach) the forecast errors are expressed in terms of percentiles, the indicated first-order autocorrelation in the errors is 0.51. If stock prices, like seasonal random walk forecasts, ignore the autocorrelation structure of seasonally differenced earnings, then the ratio of the lagged to the contemporaneous response of stock prices to earnings (calculated from equation (4)) should also be 0.51. The estimated ratio is, in fact, not significantly different from this amount at the 0.10 level. (The point estimate is 0.61; note that varying forecast horizons are not an issue here.)

Evidence indicating that stock prices are as sluggish in reflecting new earnings information as a seasonal random walk forecast may strike some readers as surprising. However, such evidence is entirely consistent with Foster (1977) and Bernard and Thomas (1990, Table 5, Panel B), who find that forecast errors from a seasonal random walk model explain contemporaneous stock price behavior better than those from more accurate statistical models.[18] On the other hand, it is difficult to explain why the market would ignore recent quarterly earnings realizations in forming expectations about future earnings, while at the same time incorporating at least some other information that predicts future earnings (Beaver, Lambert, and Morse (1980)). Clearly, further research is needed before reaching definite conclusions on this issue.

[18] See Bernard and Thomas (1990, pp. 337–338) for a discussion of conflicting results in the literature on this point. A possible explanation for the conflicting results is that, since errors from alternative forecasts are so highly correlated, it is difficult to distinguish among them in terms of the ability to explain contemporaneous stock returns. The tests used here, by explicitly incorporating estimates of the parameters of the times series process of forecast errors, as well as both lagged and contemporaneous stock price responses, should be more powerful.

V. Reconciling Analyst Underreaction to Earnings with Evidence on the Overreaction Hypothesis

Thus far, the evidence suggests that both stock prices and analysts' forecasts underreact to recent earnings announcements. An unanswered question raised by such evidence is how it could be reconciled with other evidence pointing to overreaction in stock prices (DeBondt and Thaler (1985, 1987), Chopra, Lakonishok, and Ritter (Forthcoming)) and in analysts' forecasts (DeBondt, and Thaler (1990)). We turn first to the issue of overreaction in analysts' forecasts.

DeBondt and Thaler (1990) used equation (5) below to test for overreaction in analysts' forecasts.

$$A_t - A_{t-1} = \alpha + \beta[F(A_t) - A_{t-1}] + \varepsilon_t, \tag{5}$$

where:

A_t = annual EPS for year t;

$F(A_t)$ = analysts' forecast of annual EPS for year t;

ε_t = disturbance term.

The standard definition of a rational forecast $F(A_t)$ would require that $\alpha = 0$ and $\beta = 1$. In contrast, a non-zero estimate of α indicates bias in the forecast. Several studies, including DeBondt and Thaler (1990), have documented that α is negative, suggesting that the forecasts are on average overly optimistic.

The estimate of β is the focus of our immediate concern. If forecasted changes in EPS are too extreme, then β will be less than one. DeBondt and Thaler (1990) estimate β to be 0.65, which in their sample is nearly 22 standard errors below unity. A potential concern expressed by DeBondt and Thaler is that their result could be influenced by problems with the IBES forecast data. In particular, lags between the production of an individual analyst forecast and the subsequent compilation and publication of the IBES consensus could induce a measurement error in $F(A_t)$ that might bias the estimate of β downward. This reporting lag is largely eliminated in the Value Line data used here.[19]

We report estimates of equation (5) in Table III. The first set of estimates in the table is based on analysts' forecasts reported after the announcement of the prior year's earnings, but before the first quarterly report of the year. For the case of a December-year-end firm, this would most typically represent a forecast produced and reported in March or April; the report date of the IBES forecasts used in DeBondt and Thaler was April, although such forecasts may have been produced several weeks earlier. When we use the

[19] It is possible that a forecast could be issued so soon after the prior earnings announcement that the Value Line analyst does not have time to fully incorporate the new earnings information. However, when we restrict attention to only forecasts issued at least 10 days after the prior earnings announcement, our results are essentially unchanged.

Table III

Tests of the Hypothesis that Analysts' Forecasted Earnings Changes are too Extreme 178 Firms; 1976–1986

Regression of realized earnings changes against forecasted earnings changes:

$$A_t - A_{t-1} = \alpha + \beta[F(A_t) - A_{t-1}] + \varepsilon_t, \tag{5}$$

where:

A_t = annual EPS for year t;

$F(A_t)$ = Value Line analysts' forecast of annual EPS for year.

Finding that $\beta < 1$ indicates forecasted earnings changes are overly extreme.

Timing of Annual Forecast	Estimate of α (t-statistic for Test of $\alpha = 0$)	Estimate of β (t-statistic for Test of $\beta = 1$)	R^2
Before first quarter report	−0.31 (−8.95)	0.82 (−4.86)	0.27
Before second quarter report	−0.29 (−10.57)	1.02 (1.04)	0.50
Before third quarter report	−0.18 (−8.66)	1.05 (2.95)	0.68
Before fourth quarter report	−0.09 (−4.50)	1.02 (1.54)	0.73

forecasts produced prior to the first interim report, our estimate of β is 0.82.[20] Although not as low as the DeBondt-Thaler estimate, it is still reliably less than one. (The estimate 0.82 lies nearly 5 standard errors below unity.) Thus, the essential conclusion of DeBondt and Thaler (1990) is supported when Value Line forecasts are analyzed.

The remaining estimates in Table III are based on forecasts produced later in the year—before the second, third, and fourth quarter reports, respectively. One would expect any tendency for annual earnings forecasts to be too extreme to be corrected as time goes on and interim earnings are announced. Not only is that the case, but the tendency for overly extreme forecasts is essentially eliminated after the first interim report is received. That is, in each of the last three equations in Panel A, the estimate of β is much closer to one than in the first equation.

The finding that forecasted changes generated early in the year are too extreme is characterized by DeBondt and Thaler (1990) as indicating "overreaction." The appropriateness of this characterization is not clear, however, since even random errors in earnings forecasts would tend to drive the estimate of β below one. Moreover, while the above result could be consistent with overreaction to earnings, there is one added condition that must hold to

[20] The estimate is 0.71 for large firms and 0.92 for medium-sized firms.

demonstrate such overreaction. Specifically, it must be the case that the forecasts that are too extremely high (low) are associated with firms recently experiencing strong (weak) earnings performance. Such behavior would be predicted by the description of investor overreaction to earnings in DeBondt and Thaler (1987) where investors fail to recognize that earnings are mean-reverting in the tails. Such behavior is also suggested by DeBondt and Thaler's (1987) finding that their "loser" portfolios, which seem to outperform their "winner" portfolios during the test period, have experienced weaker earnings performance prior to the test period, as if any mispricing corrected during the test period was caused by an overreaction to the prior earnings.

To obtain some sense for the appropriateness of the above characterization of the result in Table III, we turn to Figure 2, which links varying amounts of forecasted earnings changes with not only subsequent earnings realizations, but also prior year earnings behavior. Specifically, we group firms into quintiles on the basis of the forecasted change in EPS (the regressor in (5)), and then observe both prior and subsequent EPS realizations.

That the forecasts early in the year are too extreme is visible in Figure 2; note that as we move from the first forecast, through the later forecasts, and finally to the realized EPS, the lines for the quintiles move closer together. However, Figure 2 also suggests that this movement cannot be characterized as a correction of an overreaction to the prior year earnings news. Note that forecasts that turn out to be most overly optimistic are not those for which the prior earnings performance was strong. To the contrary, the most overly

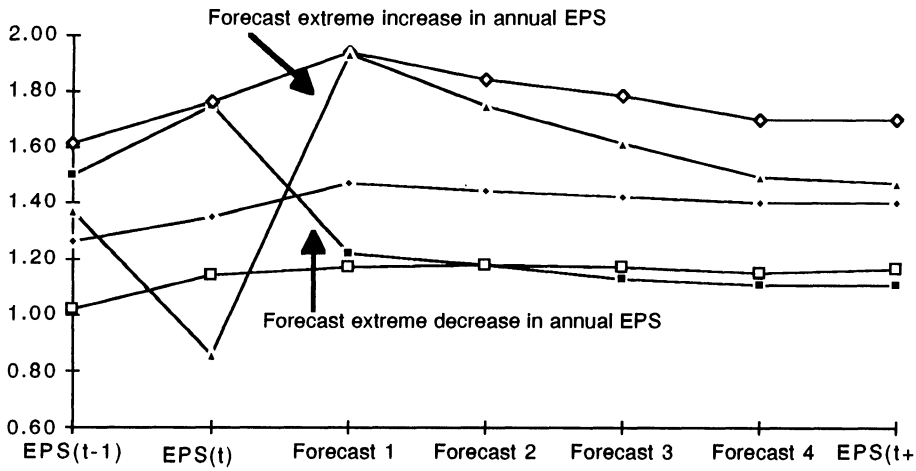


Figure 2. Path of earnings and earnings forecasts for firms grouped on forecasted change in earnings 178 firms; 1976–1986. Amounts plotted are medians within quintiles; quintiles are formed on the basis of deviation of initial Value Line forecast of EPS for year $t + 1$ (reported prior to first interim report) from EPS for year t. Forecasts 1 through 4 are reported prior to the quarterly earnings announcement for quarters 1 through 4, respectively. EPS amounts are adjusted retroactively for stock splits, and thus average level of EPS is lower than originally reported.

optimistic forecasts are for the forecast-change quintile with the weakest earnings performance in the prior year. For this quintile, median EPS fell from \$1.37 to \$0.86 in the prior year (while the overall median EPS stood at \$1.35), and yet the median analyst forecast for the following year started at \$1.93, or \$.46 higher than the ultimate realization.[21] *Although the high initial forecast may represent an overreaction to some information source, it is clearly not the prior year's earnings releases.* Since it is this quintile for which the forecasts are most in error, the results in Table III (and presumably the DeBondt-Thaler (1990) results) are driven primarily by overly optimistic forecasts for prior poor performers. (A similar conclusion is drawn in concurrent research by DeBondt (1991)).

The depiction in Figure 2 stands in stark contrast to one where investors fail to recognize mean reversion in annual earnings, and thus overreacted by expecting a maintenance of prior year earnings levels or even a continuation of the prior earnings trends. In fact, Figure 2 suggests that analysts pay too little attention to the prior year's earnings performance.

A formal test of whether overly extreme earnings forecasts are best characterized in terms of overreaction or underreaction to prior earnings can be based on the following regression:

$$A_t - F(A_t) = \gamma + \delta[A_{t-1} - A_{t-2}] + v_t \tag{6}$$

where v_t is a disturbance term and other variables are as defined above.

If $F(A_t)$ were an efficient forecast, δ would be zero. An estimate greater than (less than) zero is indicative of underreaction (overreaction) to the prior year's earnings change. The key implication of the above discussion is that δ in equation (6) can be positive, indicating underreaction, even while β in equation (5) is less than one, indicating that forecasted changes tend to be too extreme.

Estimates of (6) are presented in Table IV for forecasts generated prior to each of the four quarterly earnings reports for the year. For the first forecast of the year, the estimate of δ is positive and statistically significant, consistent with underreaction.[22] The magnitude of the coefficient indicates that, on average, annual EPS includes an amount not reflected in analysts' forecasts that is equal to 8% of the prior year's EPS change. The estimated value attenuates while remaining positive as one moves through the year, then rises to 3% for the final forecast of the year.

Detailed examination of the data underlying our estimates in Table IV confirm that, as one would expect given Figure 2, the evidence of underreaction is largely driven by a failure to recognize the degree to which weak

[21] The average level of EPS in this and the following figure are lower than mean reported levels, because of the effect of retroactively adjusting the data for stock splits and stock dividends.

[22] The estimate of δ is .09 for large firms and .07 for medium-sized firms. The likelihood of dependence in the data (across firms) suggests that the t-statistics may be overstated (see Bernard (1987)) and must therefore be interpreted cautiously.

Table IV

Tests of the Hypothesis that Analysts' Forecasts Underreact / Overreact to Prior Year Earnings Changes 178 Firms; 1976–1986

Regression of realized earnings changes against forecasted earnings changes:

$$A_t - F(A_t) = \gamma + \delta[A_{t-1} - A_{t-2}] + v_t, \tag{6}$$

where:

A_t = annual EPS for year t;

$F(A_t)$ = Value Line analysts' forecast of annual EPS for year t.

Finding that $\delta > 0$ indicates analyst underreaction to earnings.

Timing of Annual Forecast	Estimate of γ (t-statistic for Test of $\alpha = 0$)	Estimate of δ (t-statistic for Test of $\delta = 0$)	R^2
Before first quarter report	−0.44 (−13.10)	0.08 (3.30)	0.01
Before second quarter report	−0.33 (−11.81)	0.05 (2.42)	0.00
Before third quarter report	−0.21 (−9.26)	0.01 (0.67)	0.00
Before fourth quarter report	−0.08 (−5.09)	0.03 (2.45)	0.00

earnings performance tends to persist. For the quintile of firms with the largest decline in prior year EPS (from \$2.13 to \$0.84, at the median), analysts forecast a reversal sufficient to move EPS to \$1.12. These expectations tend to be disappointed, however, as the median realized value turns out to be close to the prior year level: \$0.72.[23]

In summary, although we replicate the DeBondt and Thaler (1990) finding that forecasted EPS changes tend to be too extreme, the errors in those extreme forecasts cannot be explained as an overreaction to earnings information. In fact, analysts' forecasts were most in error in situations where analysts were optimistic despite poor recent earnings performance. Although analysts may be overreacting to some other unspecified information source, they appear to be underreacting to information about earnings.

[23] The finding of analyst overoptimism conditional on prior weak *earnings* performance is consistent with Klein's (1990) finding of analyst overoptimism conditional on prior weak *stock price* performance. However, given that extreme prior stock price movements could be driven by factors other than earnings, our results need not follow from Klein's evidence. (That is, analysts could conceivably have been overly optimistic only when the extreme negative prior stock price movements were not corroborated by weak prior earnings performance.)

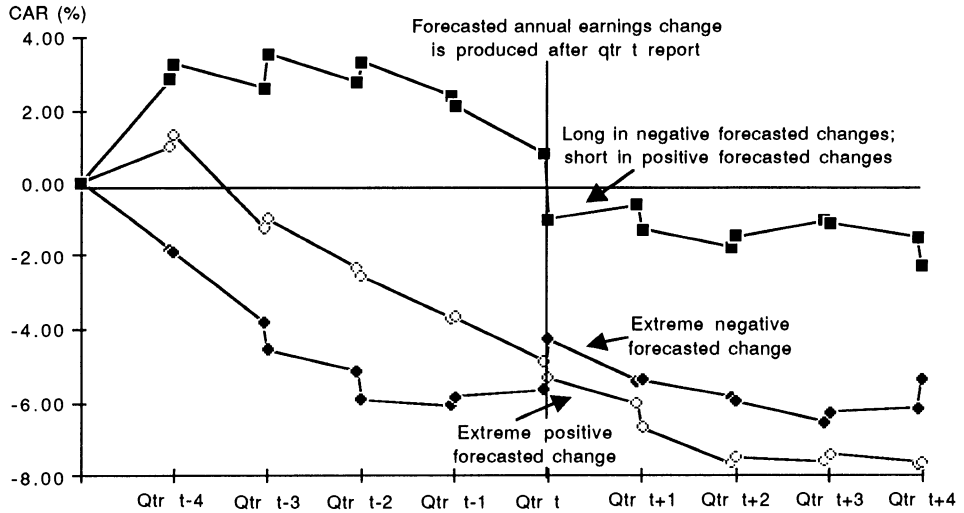


Figure 3. Stock price behavior before and after extreme analyst forecasts: path of cumulative abnormal returns for firms grouped on forecasted change in annual EPS 178 firms; 1976–1986. Firms are ranked within years on Value Line forecast of change in annual EPS over prior year, scaled by stock price ten days prior to forecast. Forecasts are reported after prior year EPS announcement (denoted qtr t) and before first quarter EPS announcement of current year (denoted $t + 1$). Cumulative abnormal (size-adjusted) returns (CARs) are plotted above for firms in top and bottom quintile of this distribution, and for the portfolio including a long position in the bottom quintile and short position in the top quintile. CARs are measured over intervals from one earnings announcement to the next; although length of interval varies by firm-quarter, it is held constant in graph for sake of clarity.

VI. Are Extreme Analyst Forecasts Accompanied by Stock Price Overreactions?

Even though we find no evidence that overly extreme analysts' forecasts represent overreactions to earnings, it is still possible that they reflect overreactions to *some* information and that they are linked with stock price overreactions. If so, then stock prices would be too extreme around the time of the extreme analysts' forecasts, and should then experience some reversion during the post forecast period, as the overreaction is ultimately corrected.

Figure 3 presents a test of the above-described overreaction hypothesis. The figure plots abnormal returns for portfolios that vary in terms of the changes in the Value Line first-quarter forecast of annual earnings, relative to earnings of the prior year. This is the same discriminator variable used in Figure 2. Thus, Figure 3 simply plots abnormal (size-adjusted) stock returns for portfolios for which earnings forecasts were plotted in Figure 2. In addition to presenting such plots for the portfolio of extreme negative and extreme positive forecasted earnings changes, however, Figure 3 also plots

the abnormal returns to the combination of a long position in the former and short position in the latter portfolio.[24]

If extreme analysts' forecasts are associated with stock price overreaction in the sense described by DeBondt and Thaler, one would expect the portfolio of extreme positive (negative) forecasted changes to be "overpriced" ("underpriced") around the time of the forecast. As the mispricing is later corrected, the portfolio that is long in the firms with extreme negative forecasted changes and short in the firms with extreme positive forecasted changes would produce positive abnormal returns.

Figure 3 presents no reliable evidence of any correction of overly extreme expectations, either over the following year as a whole, or at the time of any of the four subsequent earnings announcements. In fact, in contrast to the above prediction, the combined long-short portfolio produces negative abnormal returns over the year subsequent to the forecast. Although the magnitude of the negative returns is statistically insignificant, it is consistent with a stock price underreaction to the analysts' extreme forecasted earnings changes.

The stock price movement in the year prior to the forecast is also inconsistent with the overreaction hypothesis, for the portfolio of firms with extreme positive forecasted earnings changes and for the combined long and short position. For the positive change portfolio, the overreaction hypothesis would predict positive prior year performance, reflecting an overpricing that would be partially reversed in the following year. In contrast to this prediction, the portfolio produces strong negative prior year abnormal returns.

DeBondt (1991) conducts tests similar to those described above, based on a larger sample of IBES forecasts. He too finds that in the year prior to the forecast date, the abnormal returns do not follow the pattern predicted by the overreaction hypothesis. DeBondt's abnormal returns for the first test year (as well as the second and third test years) go in a direction consistent with the overreaction hypothesis, and in some cases are statistically significant.[25] One possible explanation for the difference between our results and those of DeBondt is that DeBondt's sample includes some small firms.[26]

[24] Consistent with the prior analysis, forecasted earnings changes are scaled by the stock price prior to the forecast. This makes it less likely that our short position will include overpriced stocks and reduces the power to capture reversals of positive overreactions. We repeated the analysis using the absolute value of prior year EPS as the scalar. The prior year stock price performance of both the positive and negative forecast change portfolios was more negative, but otherwise the results were similar to those reported here.

[25] For the case of a 12-month post-forecast holding period, the abnormal returns from combined long and short positions vary from 2.5 to 3.4 percent, with t-statistics ranging from 1.39 to 2.04, depending on how the abnormal returns are calculated. These amounts can be compared to our four-quarter post-announcement return of -1.52 percent with a t-statistic of -0.53. See Table VII Debondt (Forthcoming) for details.

[26] It should be noted that our conclusions are based on one-year ahead earnings forecasts. Debondt (Forthcoming) presents evidence on overreaction to long-term forecasts. When two- and five-year earnings forecasts are considered, t-statistics on the 12-month arbitrage portfolios range from 0.82 to 1.48, depending on how abnormal returns are calculated. Post-forecast holding periods of up to 21 months for these longer-term forecasts yield t-statistics ranging from 0.74 to 2.38 on combined long and short positions.

Neither this study nor DeBondt (1991) produces abnormal returns that approach the 10% annual abnormal return documented in the studies of long-term stock price reversals (DeBondt and Thaler (1985, 1987); Chopra, Lakonishok and Ritter (Forthcoming)). This finding, especially in combination with the pre-forecast-date behavior that departs from the predictions of the overreaction hypothesis, suggests there may be no linkage between the overly extreme analysts' earnings forecasts described in DeBondt and Thaler (1990) and the widely studied stock price reversals.

VII. Discussion and Concluding Remarks

The first message of the analysis is that even though analysts' forecasts share some of the key properties of the naive seasonal random walk forecast that appear to underlie the stock price behavior in Bernard and Thomas (1990) and Wiggins (1991), stock prices nevertheless reflect these properties to a significantly greater extent.

This first finding has implications for understanding the source of post-earnings-announcement drift. To the extent that inefficiencies in analysts' forecasts are consistent with the anomalous stock price behavior, explaining the anomaly might require understanding why even professional analysts in apparently competitive markets tend to make systematic errors in earnings forecasting context. Such errors could reflect psychological forces that cause humans in certain prediction contexts to place too little weight on recent changes in a series (Andreassen and Kraus (1990)) or could be induced by the incentive structure faced by analysts (Abarbanell (1990), Trueman (1990, 1991)).[27] However, given that stock prices appear to respond to earnings news with even more delay than do analysts, there must be more to the explanation. One possibility involves the role of transactions costs; another possibility is that, just as analysts underreact to recent earnings signals, traders may underreact to recent analysts' reports.

The second message of the empirical results is that the analyst "generalized overreaction" in DeBondt and Thaler (1990) is (1) *not* easily viewed as an overreaction to earnings and (2) *not* clearly connected to overreaction in stock prices. Together, these findings suggest that an understanding of long-term reversals in stock prices can be gained only by turning to avenues other than analyst behavior. For example, stock prices may be influenced by "sentiments" of small investors (Lee, Shleifer, and Thaler (1991)) that are driven by factors having little or nothing to do with analysts' forecasts.

The finding that overreactions to earnings cannot be found among analysts and cannot be linked to stock price reversals may explain other apparent inconsistencies in the recent literature on market efficiency. Chopra, Lakonishok, and Ritter (Forthcoming), DeBondt and Thaler (1985, 1987), Jagadeesh (1990), and Lehmann (1990) all document what appears to be an

[27] In either case, there remains the question of why the market could not "undo" the systematic biases in the forecasts.

overreaction in the stock market. In contrast, Zarowin (1989) finds no support for the DeBondt and Thaler (1987) overreaction-to-earnings hypothesis, and others (e.g., Bernard and Thomas (1989, 1990)) find indications of an underreaction to earnings. The key to understanding these apparently disparate results is that the studies documenting stock price overreaction always partition firms on the basis of prior *stock price performance*, while those documenting either no overreaction or underreaction in stock prices partition on the basis of prior *earnings performance*. A possibility consistent with all of the data is mispricing due to a variety of unidentified causes, which is most likely to surface among stocks with extreme price changes and thus be labeled an overreaction, in combination with an incomplete initial response to earnings.

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