Earnings Precision and Analyst Forecast Revisions* 

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Abstract

Burgstahler and Chuk (2009) report empirical evidence consistent with a Bayesian model where the precision of new earnings information explains the magnitude of revisions in expected future earnings implicit in market prices. In this paper, we explore evidence on revision of analysts’ explicit forecasts of future earnings in response to earnings information. The evidence shows that analyst revisions are larger for higher precision observations (just as revisions implicit in market prices are larger for higher precision). However, the overall relation for explicit analyst forecast revisions differs from the relation for implicit market forecast revisions. Because the explicit and implicit forecast revisions differ, we also explore subsequent returns to evaluate whether one revision is more consistent with subsequent market prices. We find substantial and significant positive subsequent returns, where the magnitude of returns is related to the magnitude of the positive forecast revisions, suggesting that the initial market response is not sufficiently positive for more positive forecast revisions. We also find less significant but still positive subsequent returns related to the magnitude of negative forecast revisions, suggesting that the initial market response is excessively negative for more negative forecast revisions.

JEL classification: G14, M40

Key Words: Earnings precision, analyst forecasts, uncertainty
1. Introduction

When firm value represents capitalized expected future earnings, changes in firm value correspond to changes in capitalized expected future earnings. Using a simple Bayesian model, Burgstahler and Chuk (2009, hereafter BC) show that revisions in expected future earnings implicit in market prices in response to new earnings information are substantially larger for with higher values of two proxies for precision, dispersion of analyst forecasts and magnitude of earnings surprise. This paper explores whether precision plays a similar role in explaining revisions of analysts' explicit forecasts of earnings in response to new information. That is, we investigate whether the effect of precision on the relation between analyst forecast revisions and earnings surprises is similar to the effect of precision on the relation between stock returns and surprises. We examine three research questions related to the precision of earnings information and analyst forecasts of earnings. First, does precision explain differences in revisions of analyst forecasts of earnings? Second, do revisions of explicit analyst forecasts and revisions of the market's implicit earnings forecasts differ in response to earnings surprises, and are the differences explained by precision? Third, are subsequent returns (which reflect subsequent events) predictable based on the differences between revisions of explicit analyst forecasts and implicit market forecasts of earnings?

Similar to BC’s findings on the market’s implicit forecast revisions, the results show that higher precision earnings signals lead to larger revisions in analyst forecasts. However, we document important differences between analyst revisions and market revisions. Specifically, revisions of analyst forecasts are much larger for negative earnings surprises than for positive earnings surprises, whereas the market price reaction reported in BC is approximately symmetric for positive versus negative surprises. This asymmetry implies that analyst forecasts are revised less than market revisions of future earnings for positive surprises and/or analyst forecasts are
revised more than market revisions for negative surprises. Given the substantial differences between analyst revisions and market revisions, we examine whether subsequent returns are predictable based on differences between revisions of analyst and market forecasts. We find evidence that positive subsequent returns are associated with both more positive and more negative analyst revisions. This suggests that the market reaction to the earnings surprise at the time of announcement is on average not sufficiently positive for more positive analyst revisions and is too negative for more negative analyst revisions. That is, as investors impound additional information revealed by events subsequent to the earnings announcement and refine their implicit forecasts of future earnings, (i) the price adjustments are significantly more positive following larger positive analyst revisions and (ii) price adjustments are significantly more positive following larger negative analyst revisions. Furthermore, we document that the magnitude of these subsequent market price adjustments is positively associated with the ex ante proxy for precision based on forecast dispersion.

The paper is organized as follows. Section 2 provides background. Section 3 develops predictions about analyst forecast revisions. Section 4 outlines the empirical analysis to explore these predictions. Section 5 provides results. Section 6 relates our findings to key results from prior research. Section 7 concludes.

2. Background

Using a simple Bayesian model, BC show that revisions in expected future earnings implicit in market prices in response to new earnings information are substantially larger for higher precision earnings information. BC examine two proxies for precision (the realized magnitude of earnings surprise and dispersion of analyst forecasts) and show that each proxy adds significant explanatory power relative to the other, and that together the two proxies account for most, if not all, of the large gap between empirical estimates of ERCs and theoretical
values of earnings capitalization factors. When both proxies indicate low precision, revisions of expected earnings in response to an earnings surprise are small and estimated earnings response coefficients (ERCs) are essentially 0. When both proxies indicate high precision, revisions of expected earnings are large and estimated ERCs are on the order of 30. Overall, the results suggest that expectations of future earnings implicit in market prices are revised much more in response to new earnings information with higher precision.

There are reasons to expect the relation between precision and analyst forecast revisions to be similar to the relation between precision and ERCs reported in BC. Analyst forecasts and expectations implicit in market prices are sometimes treated as the same construct – researchers in accounting and finance often treat analyst forecasts as a proxy for expectations impounded in market prices (Kothari 2001). However, the set of information impounded in analyst forecasts is potentially different than the set of information impounded in market prices. The set of information in market prices is likely to be broader than the set of information impounded in an analyst forecast, though an analyst may have access to some information not available to other market participants, and the model used to process information may be unique to an individual analyst.

Further, there is evidence from the prior literature at at least some information in earnings forecasts released by analysts is impounded in market prices. Givoly and Lakonishok 1979 and Imhoff and Lobo 1984 document that analyst forecast revisions have information content during the short-window around analyst revisions, suggesting that market prices either directly impound analyst forecast revisions or indirectly impound the same information that analysts use for forecast revisions. However, subsequent research shows the market price reaction in the short-window around forecast revisions is incomplete; after the short-window, prices continue to drift in the same direction for at least three to nine months (Stickel 1991; Gleason and Lee 2003).
Using a large sample from IBES during 1993 to 1998, Gleason and Lee 2003 find that mean buy-and-hold returns are 2.1% (-3.7%) during the three months following upward (downward) analyst revisions.\(^1\)

There are alternative reasons to expect that the effect of precision on the relation between analyst revisions and earnings surprises differs from its effect on the relation between stock returns and earnings surprises documented in BC. There are several important differences between analysts and investors. First, analysts have incentives to issue optimistic earnings forecasts due to underwriting relationships (Lin and McNichols 1997) and the desire to curry favor with management to ensure continued access to information (Francis and Philbrick 1993). Similarly, analysts may have incentives to “herd” their forecasts, whereby they issue forecasts similar to those previously announced by other analysts, even when this is not justified by their own information (Trueman 1994). Second, prior research has found mixed evidence on whether analysts react to earnings information in the same manner as investors. Similar to the underreaction by investors reported by Bernard and Thomas 1990 (BT), Abarbanell and Bernard 1992 show that analyst forecasts under-react to earnings information; analyst forecasts are less naïve than a simple seasonal random walk, but analyst forecast errors still conform to the autocorrelation patterns documented by BT for seasonally differenced earnings. In contrast, DeBondt and Thaler 1990 find that analysts’ forecasted changes are more volatile than actual earnings; the authors conclude this finding suggests analyst over-reaction, inconsistent with the investor behavior documented by BT. Our results reported below suggest that unconditional generalization of either over- or under-reaction is inappropriate. Instead, whether there is over- or under-reaction depends on the sign and magnitude of the analyst reactions.

\(^1\) In Section 6, we replicate the results in Gleason and Lee 2003 for their original sample period as well as for a later sample period. We find similar results for their original sample period but find a substantially different relation during the later sample period.
It is not possible to directly compare revisions of implicit forecasts from market prices with revisions of explicit analyst forecasts, because the revisions are measured in non-comparable units. Implicit forecasts are measured in terms of capitalized expected future earnings. Explicit forecasts are measured in terms of one-year-ahead earnings. Thus, comparisons of revisions of implicit and explicit forecast must rely on additional restrictive assumptions. For example, if we assume that capitalized expected earnings is equal to the same multiple, c, of one-year-ahead earnings for all firm-years, then price before the announcement of earnings is the product of c and the implicit forecast of one-year ahead earnings before current earnings are announced:

\[ P_{\text{Before}} = c F_{\text{Before},t+1}^{\text{implicit}}. \]

Price after the announcement reflects the updated forecast after earnings are announced

\[ P_{\text{After}} = c F_{\text{After},t+1}^{\text{implicit}}. \]

The return due to the earnings announcement is

\[ \text{Return} = \frac{P_{\text{After}} - P_{\text{Before}}}{P_{\text{Before}}} = \frac{c F_{\text{After},t+1}^{\text{implicit}} - c F_{\text{Before},t+1}^{\text{implicit}}}{c F_{\text{Before},t+1}^{\text{implicit}}} = \frac{F_{\text{After},t+1}^{\text{explicit}} - F_{\text{Before},t+1}^{\text{explicit}}}{F_{\text{Before},t+1}^{\text{implicit}}}, \]

i.e., the return is the proportional change in expected earnings.

The analysts’ explicit forecast revision scaled by price before the pre-announcement forecast is:

\[ \frac{F_{\text{After},t+1}^{\text{explicit}} - F_{\text{Before},t+1}^{\text{explicit}}}{P_{\text{Before}}} = \frac{F_{\text{After},t+1}^{\text{explicit}} - F_{\text{Before},t+1}^{\text{explicit}}}{c F_{\text{Before},t+1}^{\text{implicit}}} = \frac{1}{c} \frac{F_{\text{After},t+1}^{\text{explicit}} - F_{\text{Before},t+1}^{\text{explicit}}}{F_{\text{Before},t+1}^{\text{implicit}}}. \]

With these restrictive assumptions, c multiplied by the price scaled forecast revision is directly comparable to the return due to the earnings announcement. However, evidence in BC based

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2 Note that the expected earnings implicit in market prices is the scalar equivalent of the expected stream of all future earnings. Thus, firms with positive market value must have positive expected earnings. However, firms with positive market value could have negative expected earnings for year t+1, in which case the assumption that capitalized expected earnings is equal to the product of c and year t+1 earnings is violated.
shows that the forecast revision implicit in returns depends on earnings precision (as proxied by forecast dispersion and surprise magnitude) and explicit analyst forecast revisions may depend on these or other variables. As such, it is not possible to make direct comparisons of implicit market revisions and explicit analyst revisions.

3. Predictions

In the Bayesian model, revisions of beliefs in response to the announcement of earnings depend on the precision of the new information, as reflected in equation (1.6) of BC, where the return due to an earnings announcement, \( R \), is the product of the earnings capitalization factor, \( c \), a weight, \( w \), and the scaled earnings surprise, \( ES \):

\[
R = c \cdot w \cdot ES
\]

The weight, \( w \), is defined by the relative precision of the earnings signal. BC extend the Subramanyam (1996) model of Bayesian revision of security prices to consider the effects of both ex ante and ex post proxies for precision. Using the magnitude of earnings surprise as an ex post proxy for precision and dispersion of analyst forecasts as an ex ante proxy for precision, BC show that the coefficient on \( ES \), \( c \cdot w \), is strongly related to the precision proxies, both individually and jointly. Because the implied revision in expected earnings, \( ER \), is the product \( w \cdot ES \), the results in BC imply the revision approaches zero as \( w \) approaches zero (for earnings signals with very low precision) and approaches \( ES \) as \( w \) approaches one (for earnings signals with very high precision).

Our first research question addresses whether the fundamental predictions of this Bayesian model also apply for analysts' explicit forecasts of earnings. That is, we examine whether larger analyst forecast revisions are associated with higher precision earnings.

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3 Note that we operationalize the scaled forecast revision and the return due to the earnings announcement using slightly different measures of the price before the announcement, one price measured on the day before the pre-announcement forecast and the other measured the day before the earnings announcement.
information. Operationally, we predict a larger coefficient relating analyst forecast revisions to earnings surprise for 1) smaller magnitude earnings surprises, and 2) smaller dispersion of analyst forecasts.

Our second research question is whether revisions of explicit analyst forecasts and revisions of earnings forecasts implicit in market prices differ in response to earnings surprises and, if so, how the differences are related to precision. Differences between analyst revisions and market revisions imply the pre-announcement forecasts differ, or the post-announcement forecasts differ, or both.

To the extent the post-announcement forecasts differ, the forecast implicit in market prices may differ systematically from an unbiased forecast so that subsequent returns are predictable. This possibility is the focus of our third research question. There is likely a common set of publicly available information impounded in both market price and analyst forecasts. For instance, as documented by event studies around analyst revisions (Givoly and Lakonishok 1979), one of the key pieces of information impounded in market prices is analyst forecasts. Similarly, analysts likely use information contained in the market’s reaction to earnings announcements in revising their forecasts. However, the information impounded in analyst revisions can differ from that impounded in returns. Subsequent returns can reveal that the initial market revision was either too small or too large, such that subsequent returns can be predicted based on the past divergence between analyst explicit revisions and the market’s implicit revision around the earnings announcement.

4. Data

We consider two basic analyst forecast variables: analyst forecasts of year $t$ earnings and analyst forecasts of year $t+1$ earnings. These basic variables are in turn used to define the two basic constructs: earnings surprise for year $t$, defined as actual earnings minus the forecast, and
forecast revision for year t+1, defined as the forecast of year t+1 earnings after year t earnings are announced minus the forecast of year t+1 earnings before year t earnings are announced. We also compute a variable that we call the revision surprise. The revision surprise is defined as the analyst forecast revision minus the earnings surprise, and provides a measure of the forecast revision not explained by the earnings surprise.\(^4\)

From the IBES file, we measure analyst forecast revision for an individual analyst as the first forecast for year t+1 issued immediately following the announcement of year t’s earnings (hereafter, the post-announcement forecast) minus the last forecast by the same analyst for year t+1 issued before the announcement of year t’s results (hereafter, the pre-announcement forecast). We also measure earnings surprise as actual EPS minus the latest individual analyst forecast before the announcement of earnings for the year. From the IBES consensus file, we obtain the number of analyst forecasts used in computing the consensus forecast and the standard deviation of analyst forecasts as a measure of forecast dispersion. Earnings surprise and forecast dispersion are scaled by price at the end of the fiscal year, and forecast revision is scaled by price one day before the pre-announcement forecast.

Accounting and stock return data are obtained from Compustat and CRSP. In most cases, analyst forecasts are revised on the day of the earnings announcement or in the next few days. In order to define a return period following both the announcement of earnings and the analyst forecast, we define subsequent returns as abnormal returns (raw return minus the value-weighted

\(^4\) Note that when the pre-announcement forecasts for year t and year t+1 are the same, the revision surprise is the difference between the revised forecast for year t+1 and announced earnings for year t. In this special case, the revision surprise is the difference between the revised analyst forecast for year t+1 and announced earnings for year t.
market return) accumulated over a 90-day window beginning 5 days after the earnings announcement.\(^5\)

Analyst forecast revisions can be measured at the level of either individual analyst or consensus forecasts.\(^6\) Most of the analysis reported in Section 5 focuses on results for individual analyst forecasts.\(^7\) However, unreported analysis performed at the consensus level provides conclusions qualitatively similar to those reported below.

Table 1 provides descriptive statistics for our sample. The distribution of price-scaled earnings surprise measured relative to individual analyst forecasts is approximately equal to the distribution of price-scaled earnings surprise measured relative to consensus forecasts. Both distributions have mean and median values close to zero. However, earnings surprises for individual analysts have higher standard deviation than for the consensus, consistent with the idea that the consensus forecast has less idiosyncratic error than individual analyst forecasts.

Analyst forecast revision is generally of the same sign as the earnings surprise, indicating that analysts tend to increase (decrease) their forecasts for year \(t+1\) when realized earnings for year \(t\) is greater (less) than their forecasts for year \(t\). On average, the revision surprise is negative; on average, forecasts are revised less optimistically than the earnings surprise, i.e., for negative surprises the forecast is revised downward by more than the earnings surprise and for positive surprises, forecasts are revised upward by less than the earnings surprise.\(^8\) Consistent with previous findings, the three-day market-adjusted returns around the earnings announcement are

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\(^5\) As discussed later, we delete from our sample analyst revisions that occur 5 or more days after the announcement so the return period does not start until after the forecast revision is issued.

\(^6\) From a research design perspective, these alternatives reflect different implicit weights. Individual analyst forecasts place equal weight on each analyst forecast for each firm-year while consensus forecasts place equal weight on each firm-year. To the extent that results for different analysts are independent, each analyst represents a separate, informative observation and each analyst forecast should be included separately, and weighted equally, in the analysis. On the other hand, to the extent that results for different analysts for the same firm-year are highly dependent, consensus forecasts should be examined to place equal weight on the single consensus forecast for each firm-year and avoid counting multiple observations for the same firm-year.

\(^7\) Gleason and Lee 2003 also use individual analyst revisions as their unit of analysis in most of their empirical tests.

\(^8\) Figure 1 provides more detail on this issue.
often, but not always, of the same sign as the earnings surprise. The number of analysts in the consensus forecast is higher than in BC; our sample selection criterion requiring an intervening earnings announcement between forecast revisions results in a sample of firms more heavily followed by analysts than the sample in BC. Price-scaled forecast dispersion, computed as the scaled standard deviation of analyst forecasts for observations with at least four analyst forecasts in the consensus forecast, is similar to that reported in BC.

We focus on IBES individual analyst forecasts of annual earnings for firm-years from 1992 to 2007 for which 1) the consensus includes at least four analysts (so that forecast dispersion is defined in the sense discussed in BC), and 2) there is a forecast by the same analyst for year t+1 immediately before and after the announcement of earnings for year t (to measure the explicit forecast revision in response to the earnings announcement). We restrict our sample to instances in which the analyst issues a pre-announcement forecast for year t+1 on the same day as issuing the forecast for year t that is used in the computation of the analyst’s earnings surprise for year t. We further restrict our sample to instances in which the pre-announcement forecast is within 90 days before the earnings announcement and the post-announcement forecast is within four days after the earnings announcement. These two restrictions, respectively, ensure that the forecast used to compute the analyst’s earnings surprise for year t is not a stale forecast and reduce the likelihood that the post-announcement forecast for year t+1 is in response to information other than that contained in the announcement of earnings surprise for year t.

Using individual forecasts, as opposed to consensus forecasts, allows us to impose stricter controls over chronology and proximity cutoffs for forecast dates relative to earnings

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9 Because we are interested in measuring revision in analysts’ beliefs about year t+1 after analysts observe the earnings surprise for year t, this latter restriction ensures that analysts are using a constant information set when issuing forecasts for both years t and t+1 so that we avoid (incorrectly) interpreting instances of analysts using a different initial information set to forecast year t+1 than that used to forecast year t as belief revision about year t+1 due to observing results for year t.

10 In the full sample before imposing these data restrictions, the post-announcement forecast occurs within 4 (12) days after the earnings announcement for 50% (75%) of our observations.
announcements and relative to dates on which the same analyst issues other forecasts.\textsuperscript{11} The following timeline illustrates the timing of the variables measured:

\begin{figure}
\centering
\includegraphics[width=\textwidth]{timeline}
\end{figure}

5. Results

5.1 Research Question 1

In Figure 1, we form portfolios of 1,000 based on earnings surprise to provide evidence on our first research question for all observations with defined dispersion (i.e., the consensus includes at least four analysts).\textsuperscript{12} The figures show the median and mean for each portfolio of similar-magnitude revisions of the earnings forecasts for year $t+1$ against the earnings surprise measured relative to the analyst’s own earnings forecast for year $t$.\textsuperscript{13} Figure 1 plots the relation between individual analyst forecast revisions and earnings surprises. Figure 2 Panels A, B, and C plot the relations using portfolios of 500 for subsets corresponding to low, medium, and high dispersion of forecasts.

\begin{itemize}
\item Pre-announcement forecast for year $t+1$
\item Forecast for year $t$ used in earnings surprise
\item Post-announcement forecast for year $t+1$
\item Subsequent 90-day returns starting 5 days after announcement
\end{itemize}

\textsuperscript{11} Consensus forecasts are issued on the third Thursday of every month even if the individual forecasts comprising the consensus were made at different times during the month.

\textsuperscript{12} The consensus forecast based on at least four individual forecasts is not required to measure the individual analyst forecast revisions and earnings surprises, but rather to measure dispersion in analyst forecasts.

\textsuperscript{13} Portfolios are formed as follows: All zero earnings surprises are place in a single portfolio with size shown in the heading of each figure. The 1,000 smallest scaled earnings surprises are placed in the first positive earnings surprise portfolio, and next 1,000 smallest scaled earnings surprises are placed in the second positive portfolio, and so on. Portfolios of negative surprises are formed similarly, starting with the 1,000 smallest magnitude negative earnings surprises. The plots show the mean and median of the variable on the vertical axis, plotted against the median earnings surprise for the portfolio on the horizontal axis.
Focusing on the median analyst forecast revision, the sign of the revision is generally consistent with the sign of the earnings surprise. When actual earnings is greater (less) than the forecast for year t, the median forecast revision for year t+1 is upward (downward). However, many of the mean forecast revisions are negative, even for positive earnings surprises. Also, while the plots do not show the entire distribution of forecast revisions, there are numerous instances where the sign of the forecast revision does not match the sign of the surprise. A simple, naïve prediction would be that analysts revise the forecast to equal announced earnings, so that the revision of the forecast is equal to the earnings surprise. Geometrically, the prediction is that observations would lie along the dashed line drawn in the figure where revision equals earnings surprise. However, forecast revisions generally do not lie along this dashed line. For both positive and negative earnings surprises, mean and median forecast revisions for the earnings surprise portfolios fall below the dashed line. Thus, there is an asymmetry for positive versus negative earnings surprises. For positive earnings surprises, analyst forecast revisions are smaller than the corresponding earnings surprise. For negative earnings surprises, analyst forecast revisions are larger in magnitude than the corresponding earnings surprise. This is in contrast to the relation for implicit market forecast revisions based on results from BC where the relation is relatively symmetric.

For comparison, we include the plots from BC of market returns around the earnings announcement versus the earnings surprise in Figure 2 Panels A’, B’, and C’ below Panels A, B, 

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14 Although the earnings surprise is nominally for annual earnings, earnings for the first three quarters have almost always been announced prior to the forecast prior to the annual earnings announcement. Thus, the earnings surprise is effectively a fourth-quarter earnings surprise, whereas the forecast revisions pertain to annual earnings. Thus, an alternative simple model might predict revisions that are more than 1, and perhaps up to 4, times the earnings surprise. For this alternative simple model, the observations are even further below the predicted values.

15 This result is in some ways analogous to the “torpedo effect” documented by Skinner and Sloan 1992, who find that market returns are asymmetrically more negative for negative earnings surprises for growth firms. Note that BC did not find evidence of the torpedo effect for market returns.
and C, respectively. Panels A’, B’, and C’ plot the returns relation for low, medium, and high
dispersion subsets, respectively.

The aggregate relation in Panel A of Figure 1 combines results across all values of
forecast dispersion, an ex ante proxy for precision. Panels A, B, and C of Figure 2 provide
evidence that the relation between analyst forecast revisions and earnings surprise depends on
forecast dispersion, as the relation between forecast revisions and surprise is somewhat less
steeply-sloped for higher dispersion analyst forecasts. There is also a pronounced downward
shift of the relation as dispersion increases, i.e., for observations with higher dispersion of
analyst forecasts, forecasts are revised to a lower level for any given level of earnings surprise.

In Table 2, we report results of regressing analyst forecast revisions on the earnings
surprise by various ranges of earnings surprise and forecast dispersion. Panel A presents
results for all observations with defined dispersion. Panels B, C, and D present results for the
low, medium, and high forecast dispersion subsets, respectively. We also report results
separately for positive earnings surprises in columns (I) to (IV) and negative earnings surprises
in columns (V) to (VIII). The estimates in Table 2 are consistent with Figures 1 and 2.
Consistent with the downward shift across Panels A to C in Figure 2, the intercepts for both
positive and negative earnings surprises in the medium and high dispersion subsets in columns
(II) and (VI) are statistically less than the intercepts in the low dispersion subset for the
corresponding earnings surprise range. The slope coefficients relating the forecast revision to the
earnings surprise are generally statistically positive for earnings surprises of both signs (columns
(III) and (VII)), indicating that positive (negative) revisions tend to follow positive (negative)
earnings surprises. However, the slope coefficients are not significantly larger for the low
dispersion subset than the medium and high dispersion subset. Consistent with the strong visual

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16 We do not include zero earnings surprise observations in these regressions, as we do not have a prediction for the
sign of analyst forecast revision in response to zero earnings surprise.
evidence, the slopes for negative earnings surprises are statistically greater than the slopes for positive earnings surprises for almost all ranges of earnings surprise and dispersion subsets. The r-squareds for negative earnings surprises are also higher than for positive earnings surprises, suggesting that negative earnings surprises have more explanatory power for analyst revisions than positive earnings surprises.

Finally, the asymmetry between positive versus negative surprises is more clear-cut for lower forecast dispersion observations (corresponding to higher levels of the ex ante precision proxy) comparing results across Panels A, B, and C of Figure 2 and for smaller magnitude surprises (corresponding to higher levels of the ex post precision proxy). Thus, it appears that both the magnitude and sensitivity of revisions with respect to earnings surprise depend on the sign of the earnings surprise.

5.2 Research Question 2

There are several strong similarities between the relations plotted in Panels A through C of Figure 2 for analyst forecast revisions and the corresponding relations from BC for revisions of forecasts implicit in market prices plotted in Panels A’ through C’ of Figure 2. Positive (negative) revisions often, but not always, accompany positive (negative) earnings surprises. Both relations show proportionally smaller revisions for larger earnings surprises, consistent with magnitude of surprise serving as an ex post proxy for precision, and both show evidence that forecast dispersion serves as an ex ante proxy for precision. However, there is also an important difference between the two sets of relations in that the relation for analyst forecasts is asymmetric for positive versus negative surprises. For the aggregate relation in Panel A in Figure 1, as well as the dispersion subsets in Panels A, B, and C in Figure 2, the upper part of the relation flattens more quickly and substantially as the magnitude of the positive surprise increase,
while the lower part of the relation has a steeper slope and flattens out more slowly as the magnitude of the negative surprise increases.

Comparing Panels A to C versus A’ to C’ in Figures 1 and 2, it appears that there are differences in how analysts and investors revise their forecasts in response to the earnings announcement. In the next sub-section, we examine whether subsequent returns can be predicted based on factors related to the divergence between analyst explicit revisions and the market’s implicit revision around the earnings announcement.

5.3 Results for Research Question 3

To address our third research question, we examine returns subsequent to the earnings announcement to assess the predictability of information that becomes available after the earnings surprise and the forecast revision. We report results for returns in the 90 days beginning 5 days after the earnings announcement. In Figure 3 Panel A, we plot 90-day returns beginning 5 days after the earnings announcement against the revision surprise for the years 1999 to 2007.\(^{17}\) There is a clear V-shaped relation; subsequent returns are more positive for larger magnitude revisions of both signs. Results by dispersion group in Panels B, C, and D show that the strength of the V-shaped relation depends on dispersion of analyst forecasts – for low dispersion forecasts, the relation becomes more pronounced but for high dispersion forecasts, there is little evidence of a systematic relation.\(^{18}\) This result suggests that the market reaction to the earnings surprise at the time of announcement is on average not sufficiently positive for the larger positive analyst revisions and is too negative in cases for the more negative analyst revisions. As information is revealed by subsequent events, the implicit forecasts of

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\(^{17}\) For reasons explained in Section 6, we exclude observations prior to 1999.

\(^{18}\) Unreported results show that this return persists but is only marginally stronger when the return period is extended out to 360 days. That is, almost all of the systematic effect on returns appears to be concentrated in the first 90 days following the earnings announcement. Further analysis also shows that the return effect is not concentrated around announcement dates of future quarterly earnings.
future earnings in market prices are adjusted. The largest subsequent market returns occur in the high precision (low dispersion) subset.

Table 3 reports the results of regressing subsequent returns on the revision surprise by analyst dispersion subset and the sign of the revision surprise. The slopes in column (III) for positive revisions are positive and become statistically less positive moving from the low dispersion subset to the high dispersion subset. In contrast, the slopes in column (VII) for negative revision surprises are not significantly different from zero and do not become statistically smaller as we move from the low dispersion subset to high dispersion subset. Finally, the slopes for positive revision surprises in column (III) are statistically different from the slopes for negative revision surprises in column (VII).

In summary, our main results in Figures 1 to 3 and Tables 2 to 3 are consistent with a Bayesian model where higher precision earnings signals lead to larger revisions in analyst forecasts, similar to evidence in BC that revisions implicit in market prices are larger for higher precision earnings signals. However, analyst forecasts are revised less than market assessments of future earnings for positive earnings surprises and/or analyst forecasts are revised more than market assessments for negative earnings surprises. The differences between market and analyst revision functions explain subsequent returns. These results suggest that subsequent returns are predictably positive for more positive and more negative analyst revisions, and the magnitude of predictable subsequent returns is increasing in precision.

In the next section, we relate our findings to prior research. It is important to note that unlike prior studies, our explanatory variable in Figure 3 and Table 3 is the revision surprise. Unreported results using the forecast revision, as opposed to the revision surprise, show even stronger V-shaped relations than those reported in Figure 3.
6. Comparison to prior research

In this section, we explore how our findings relate to previous results in the literature on returns subsequent to earnings announcements and analyst forecast revisions. In particular, we examine the relation of our results to the post-earnings announcement drift (Bernard and Thomas 1990) and the post-revision price drift (Stickel 1991; Gleason and Lee 2003). These two key results from the prior literature demonstrate that future returns are systematically related to information in past earnings announcements and analyst forecast revisions, respectively. Similarly, our results suggest that abnormal returns are systematically related to differences between past revisions of explicit analyst forecasts and implicit market forecasts. That is, our evidence suggests that revisions in expected future earnings implicit in market prices do not fully impound information contained in explicit analyst revisions after earnings announcements.

Our results do not appear to be explained by the post-earnings announcement drift (PEAD). Because our Figure 1 documents a positive association between earnings surprise and analyst revision, there is the possibility that the relation between subsequent returns and analyst revision is driven mechanically by the positive association between earnings surprise and analyst revision. However, recall that the variable used in the returns plots (Figures 2 and 3) is the revision surprise. Removing the earnings surprise from the total analyst revision reduces the effect of the PEAD. Moreover, results driven by PEAD should exhibit a monotonic relation between 90-day returns subsequent to earnings announcements and the earnings surprise, as prices continue to drift in the direction of the initial market reaction to earnings surprise. Instead, we observe a v-shaped relation between subsequent returns and revision surprise in Figure 3. Finally, more extensive, though unreported, analysis shows no evidence that the systematic return effects we observe are concentrated around the time of subsequent earnings
announcements, as has been characteristic of results in the literature on PEAD. For these reasons, we do not believe that PEAD is driving our results.

Second, our results are also not explained by the post-revision price drift (PRPD). The PRPD relates returns to the sign of all analyst revisions while our tests relate returns to revision surprises immediately following earnings announcements. However, there is quite a bit of overlap between the two analyses, as a majority of forecast revisions occur shortly after earnings announcements, so a majority of all forecast revisions are revisions around earnings announcements. Gleason and Lee 2003 (GL) report significantly positive mean returns following upward forecast revisions and significantly negative mean returns following downward forecast revisions. To explore whether our results can be explained by PRPD, we replicate GL during their original sample period, 1993 to 1998. The results in Figure 4 Panel A provide a more detailed version of the GL results, with the mean and quartile returns shown by portfolio formed on the scaled analyst revision. The results show an S-shaped relation between post-revision returns and the individual analyst forecast revision. The mean returns over 90 days following positive versus negative forecast revisions are consistent with those reported in GL’s Table 2: 2.1% (-3.7%) buy-and-hold returns for positive (negative) forecast revisions.

GL also report that the magnitude of PRPD is decreasing in analyst following. Following GL, we disaggregate the observations into low, medium, and high analyst following in Figure 4 Panels B, C, and D, respectively. Consistent with GL’s results, the magnitude of the positive and negative returns following analyst revisions decreases as we move from low to high analyst following in Panels B to D of Figure 4, as reflected in an S-shape that becomes less pronounced as we move across the three panels.

In Figure 5 we again replicate GL but instead using a later, sample period: 1999 to 2007. In stark contrast to the S-shaped relation in Figure 4, there is a strong V-shaped relation in Figure
suggesting that the nature of PRPD has changed substantially in this later sample period. For negative forecast revisions, the return following the revision is substantially more positive for more negative revisions, whereas in the GL sample period the return following negative forecast revisions was consistently negative. Unreported analysis of year-by-year results suggests that a fairly well-defined change in the relation occurred between 1998 and 1999, though the explanation is unclear. One possible explanation is that arbitrageurs have caused the PRPD to change in recent years, though we would expect arbitrage to attenuate PRPD, not reverse its sign and increase its magnitude. [Note to workshop participants: We are frankly puzzled by this clear and dramatic change between 1998 and 1999. Suggestions of possible explanations would be greatly appreciated. We are also working on some additional analysis that may be ready by the time of the workshop.]

Because analyst forecast dispersion is empirically related to analyst following, the effects of dispersion we observe in Figures 1 to 3 could, in principle, be explained by the effects of analyst following reported in GL and shown in our Figure 4. To further examine this issue, in Figure 6 we replicate Figure 5 after performing a dependent sort to separate the effects of analyst following and forecast dispersion. Specifically, we first sort observations according to analyst following group (low, medium, and high analyst following), and then separate observations in each analyst following group into low, medium, and high forecast dispersion subsets. The sort results in nine subsets with results presented in nine panels of Figure 6, where (i) analyst following increases from low to high as we move from left to right within any given row while forecast dispersion is held constant, and (ii) forecast dispersion increases from low to high as we move from top to bottom within any given column while analyst following is held constant. Holding constant analyst following, the v-shaped pattern varies strongly with forecast dispersion within each column, where the v-shape is most prominent in the low dispersion subset and
becomes weaker as dispersion increases. In contrast, holding constant forecast dispersion within each row, there is little variation in the v-shaped pattern as we move from low to high analyst following. Further, there appears to be a general downward shift in overall mean returns as we move from low dispersion to high dispersion, where mean returns for most portfolios are positive when forecast dispersion is low, while mean returns for the majority of portfolios become negative as forecast dispersion increases. The analysis in Figure 6 shows that forecast dispersion has substantial incremental explanatory power relative to analyst following, whereas analyst following has little incremental explanatory power relative to forecast dispersion. For these reasons, we do not believe that our results are driven by the relation between our forecast dispersion proxy and the analyst following proxy that explains PRPD.

A major issue that remains is whether the patterns in Figure 3 and Figures 5 and 6 are driven by differences between implicit market forecast revisions versus explicit analyst forecast revisions in response to an earnings announcement (our original motivation for examining returns subsequent to revisions), or whether they are a more general property of analyst forecast revisions (since the V-shape relation between subsequent returns and analyst revision appears in data that does not condition on the existence of an earnings announcement). Exploration of this issue is in process.

7. Conclusion

This paper investigates whether the effect of precision on the relation between analyst forecast revisions and earnings surprises is similar to its effect on the relation between stock returns and surprises. In particular, we examine (1) how precision impacts the magnitude of explicit analyst forecast revisions in response to earnings surprises, (2) how analyst revisions and revisions of the market’s implicit earnings forecasts differ, and how these differences are explained by precision, and (3) whether subsequent returns are predictable based on differences
between revisions of explicit analyst forecasts and implicit market forecasts of earnings. We find that higher precision earnings signals lead to larger revisions in analyst forecasts, similar to revisions implicit in market prices. At the time of the earnings announcement, analyst forecasts are revised less than market assessments of future earnings for positive surprises and/or analyst forecasts are revised more than market assessments for negative surprises. Subsequent returns are predictably more positive for both more positive and more negative analyst revisions, with the magnitude of subsequent returns increasing in precision.
References


Table 1
Descriptive Statistics

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<th>Measure</th>
<th>N</th>
<th>P25</th>
<th>P50</th>
<th>P75</th>
<th>Mean</th>
<th>Std Dev</th>
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<tr>
<td>Earnings Surprise for Individual Analysts</td>
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<td>0.000</td>
<td>0.000</td>
<td>0.002</td>
<td>0.000</td>
<td>0.008</td>
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<tr>
<td>Earnings Surprise for Consensus</td>
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<td>0.000</td>
<td>0.002</td>
<td>0.000</td>
<td>0.007</td>
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<td>Analyst Forecast Revision, By ES</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>Negative Earnings Surprise</td>
<td>6,702</td>
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<td>-0.003</td>
<td>0.000</td>
<td>-0.008</td>
<td>0.017</td>
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<tr>
<td>Zero Earnings Surprise</td>
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<td>0.001</td>
<td>-0.004</td>
<td>0.012</td>
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<td>0.001</td>
<td>0.003</td>
<td>0.000</td>
<td>0.012</td>
</tr>
<tr>
<td>All</td>
<td>22,482</td>
<td>-0.005</td>
<td>-0.001</td>
<td>0.002</td>
<td>-0.004</td>
<td>0.015</td>
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<td>-0.001</td>
<td>0.001</td>
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<td>3-Day Returns Around Announcement, By ES</td>
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<tr>
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<td>-0.003</td>
<td>0.029</td>
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<tr>
<td>Positive Earnings Surprise</td>
<td>13,560</td>
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<td>0.013</td>
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<tr>
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<td>0.003</td>
<td>0.043</td>
<td>0.005</td>
<td>0.077</td>
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<td>90-Day Returns After Announcement, By ES</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Negative Earnings Surprise</td>
<td>6,672</td>
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<td>0.011</td>
<td>0.107</td>
<td>0.020</td>
<td>0.184</td>
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<td>Zero Earnings Surprise</td>
<td>2,179</td>
<td>-0.069</td>
<td>0.008</td>
<td>0.118</td>
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<td>0.181</td>
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<td>0.026</td>
<td>0.192</td>
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<td>0.193</td>
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<td>90-Day Returns After Announcement, By Revision</td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>Negative Unexplained Revision</td>
<td>13,187</td>
<td>-0.074</td>
<td>0.010</td>
<td>0.108</td>
<td>0.019</td>
<td>0.183</td>
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<tr>
<td>Zero Unexplained Revision</td>
<td>10</td>
<td>0.058</td>
<td>0.097</td>
<td>0.156</td>
<td>0.083</td>
<td>0.152</td>
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<tr>
<td>Positive Unexplained Revision</td>
<td>9,189</td>
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<tr>
<td>All</td>
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<td>0.012</td>
<td>0.117</td>
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<td>13</td>
<td>20</td>
<td>14</td>
<td>9</td>
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<td>Forecast Dispersion</td>
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<td>0.000</td>
<td>0.001</td>
<td>0.002</td>
<td>0.002</td>
<td>0.004</td>
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### Table 2
Regression of Forecast Revisions On Prior Earnings Surprise

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<thead>
<tr>
<th>(I)</th>
<th>(II)</th>
<th>(III)</th>
<th>(IV)</th>
<th>(V)</th>
<th>(VI)</th>
<th>(VII)</th>
<th>(VIII)</th>
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<tr>
<td>+/- Range of ES</td>
<td>Positive Earnings Surprises</td>
<td>Negative Earnings Surprises</td>
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<td><strong>Panel A: Aggregate Estimates</strong></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>β₀</td>
<td>β₁</td>
<td>R²</td>
<td>N</td>
<td>β₀'</td>
<td>β₁'</td>
<td>R²</td>
</tr>
<tr>
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<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
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<td>0.4613</td>
<td>10.7%</td>
</tr>
<tr>
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<td>12,342</td>
<td>-0.0009</td>
<td>0.1937</td>
<td>5,591</td>
<td>-0.0038</td>
<td>0.8824</td>
<td>6.6%</td>
</tr>
<tr>
<td>0.01</td>
<td>11,891</td>
<td>-0.0011</td>
<td>0.2745</td>
<td>5,080</td>
<td>-0.0029</td>
<td>1.3740</td>
<td>5.7%</td>
</tr>
<tr>
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<td>10,683</td>
<td>-0.0008</td>
<td>0.0877</td>
<td>4,429</td>
<td>-0.0020</td>
<td>2.0225</td>
<td>4.3%</td>
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<tr>
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<td>8,601</td>
<td>-0.0008</td>
<td>0.0173</td>
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<td>-0.0020</td>
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<tr>
<td>0.00125</td>
<td>5,943</td>
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<td>-0.0009</td>
<td>4.1477</td>
<td>2.0%</td>
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<p>| <strong>Panel B: Low Dispersion Subset</strong> | | | | | | | |</p>
<table>
<thead>
<tr>
<th>N</th>
<th>β₀</th>
<th>β₁</th>
<th>R²</th>
<th>N</th>
<th>β₀'</th>
<th>β₁'</th>
<th>R²</th>
</tr>
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<tr>
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<td>4,808</td>
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<td>1,557</td>
<td>-0.0017</td>
<td>0.8203</td>
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<tr>
<td>0.01</td>
<td>4,785</td>
<td>0.0001</td>
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<td>4,673</td>
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<td>-0.0015</td>
<td>0.9399</td>
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<td>4,362</td>
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<p>| <strong>Panel C: Medium Dispersion Subset</strong> | | | | | | | |</p>
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<tr>
<th>N</th>
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<th>β₁</th>
<th>R²</th>
<th>N</th>
<th>β₀'</th>
<th>β₁'</th>
<th>R²</th>
</tr>
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<td>4,331</td>
<td>-0.0014</td>
<td>0.5417</td>
<td>1,951</td>
<td>-0.0038</td>
<td>0.5964</td>
<td>3.4%</td>
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<tr>
<td>0.01</td>
<td>4,253</td>
<td>-0.0019</td>
<td>0.8184</td>
<td>1,879</td>
<td>-0.0033</td>
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<td>0.005</td>
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<td>1,735</td>
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<td>0.0025</td>
<td>2,964</td>
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<td>-0.0026</td>
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<td>0.00125</td>
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<td>-0.0018</td>
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<p>| <strong>Panel D: High Dispersion Subset</strong> | | | | | | | |</p>
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<tr>
<th>N</th>
<th>β₀</th>
<th>β₁</th>
<th>R²</th>
<th>N</th>
<th>β₀'</th>
<th>β₁'</th>
<th>R²</th>
</tr>
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<td>-0.0069</td>
<td>0.7245</td>
<td>&gt; 3.0%</td>
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<td>1,756</td>
<td>-0.0055</td>
<td>1.1784</td>
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</tr>
<tr>
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<td>0.4528</td>
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<td>634</td>
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<td>-2.8020</td>
<td>452</td>
<td>-0.0051</td>
<td>2.4701</td>
<td>&gt; 0.0%</td>
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</tbody>
</table>

*** Significantly greater than zero at p=0.01
** Significantly greater than zero at p=0.05
* Significantly greater than zero at p=0.10

+++ Significantly less than β₀ (or β₀') for low dispersion group at p=0.01
++ Significantly less than β₀ (or β₀') for low dispersion group at p=0.05
+ Significantly less than β₀ (or β₀') for low dispersion group at p=0.10

+++ Significantly less than β₁ (or β₁') for low dispersion group at p=0.01
++ Significantly less than β₁ (or β₁') for low dispersion group at p=0.05
+ Significantly less than β₁ (or β₁') for low dispersion group at p=0.10

>>> Significantly greater than β₁ for positive ES at p=0.01
>> Significantly greater than β₁ for positive ES at p=0.05
> Significantly greater than β₁ for positive ES at p=0.10
Table 3
Regression of Subsequent Returns On Unexplained Forecast Revisions
Subsequent Returns = \( \lambda_0 + \lambda_1 \) Unexplained Forecast Revision + \( \varepsilon \)

<table>
<thead>
<tr>
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<th>Positive Unexplained Forecast Revisions</th>
<th>Negative Unexplained Forecast Revisions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>( \lambda_0 )</td>
</tr>
<tr>
<td>Aggregate Estimates</td>
<td>6,880</td>
<td>0.0228</td>
</tr>
<tr>
<td>Low Dispersion Subset</td>
<td>3,079</td>
<td>0.0099</td>
</tr>
<tr>
<td>Medium Dispersion Subset</td>
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<td>0.0188</td>
</tr>
<tr>
<td>High Dispersion Subset</td>
<td>1,646</td>
<td>0.0531</td>
</tr>
</tbody>
</table>

>>> Significantly greater than zero at p=0.01
>> Significantly greater than zero at p=0.05
* Significantly greater than zero at p=0.10

<<< Significantly less than zero at p=0.01
<< Significantly less than zero at p=0.05
* Significantly less than zero at p=0.10

*** Significantly less positive than \( \lambda_1 \) for low dispersion at p=0.01
** Significantly less positive than \( \lambda_1 \) for low dispersion at p=0.05
* Significantly less positive than \( \lambda_1 \) for low dispersion at p=0.10

*** Significantly less negative than \( \lambda_1 \) for low dispersion at p=0.01
** Significantly less negative than \( \lambda_1 \) for low dispersion at p=0.05
* Significantly less negative than \( \lambda_1 \) for low dispersion at p=0.10

\( \times \) Significantly less than \( \lambda_1 \) for positive revisions at p=0.01
\( \times \) Significantly less than \( \lambda_1 \) for positive revisions at p=0.05
\( \times \) Significantly less than \( \lambda_1 \) for positive revisions at p=0.10
Figure 1

Panel A: Individual Forecast Revision Versus Individual Prior Earnings Surprise
Portfolios of 1000 Observations With 2,060 Exact Zeros
All Observations With Defined Dispersion n = 20,706

Panel A’: Returns Versus Consensus Earnings Surprise
Portfolios of 1,000 Observations With 5,061 Exact Zeros
All Observations With Defined Dispersion n = 56,945
Figure 2: Revision By Dispersion Subsets
Analyst Revision Versus Earnings Surprises in Panels A to C
Implicit Market Revision Versus Earnings Surprises in Panels A’ to C’

Panel A: Low Dispersion Subset n = 7,502
Portfolios of 500 Observations With 1,065 Exact Zeros

Panel B: Medium Dispersion Subset n = 7,054
Portfolios of 500 Observations With 673 Exact Zeros

Panel C: High Dispersion Subset n = 6,150
Portfolios of 500 Observations With 322 Exact Zeros

Panel A’: Low Dispersion Subset n = 9,787
Portfolios Of 500 With 1,713 Exact Zeros

Panel B’: Medium Dispersion Subset n = 9,764
Portfolios Of 500 With 997 Exact Zeros

Panel C’: High Dispersion Subset n = 9,800
Portfolios Of 500 With 463 Exact Zeros
Median return
Mean return
25 and 75 percentiles

Figure 3
90-Day Returns After Earnings Announcement Versus Revision Surprise

Abnormal Stock Returns
-0.20
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
0.20

Median Revision Surprise

Panel A: All Observations With Defined Dispersion n = 16,880
Portfolios of 1000 Observations With 3 Exact Zeros Omitted
Figure 4

90-Day Returns After Revision Versus Revision

Panel A: All Observations  n = 558406
Portfolios of 5000 Observations With 7,469 Exact Zeros

Abnormal Stock Returns

Price-Scaled Revision

Portfolios of 5000 Observations With 7,469 Exact Zeros
Years 1993 to 1998
90-Day Returns After Revision Versus Revision

Figure 4
Figure 4
90-Day Returns After Revision Versus Revision
Portfolios of 5000 Observations With 2,681 Exact Zeros
Panel B: Low Analyst Following Subset n = 178309

Abnormal Stock Returns

Price-Scaled Revision

Figure 4
90-Day Returns After Revision Versus Revision
Portfolios of 5000 Observations With 2,331 Exact Zeros
Panel C: Medium Analyst Following Subset n = 160987

Abnormal Stock Returns

Price-Scaled Revision

Figure 4
90-Day Returns After Revision Versus Revision
Portfolios of 5000 Observations With 2,457 Exact Zeros
Panel D: High Analyst Following Subset n = 211110

Abnormal Stock Returns

Price-Scaled Revision
Figure 5
90-Day Returns After Revision Versus Revision
Years 1999 to 2007
All Observations n = 858274
Portfolios of 5000 Observations With 8,061 Exact Zeros

Abnormal Stock Returns

-0.20 -0.15 -0.10 -0.05 0.00 0.05 0.10 0.15 0.20

Price-Scaled Revision

-0.02 -0.01 0.00 0.01 0.02
Figure 6
90-Day Returns After Revision Versus Revision By Analyst Following and Dispersion
Years 1999 to 2007

Low AF and Low Dispersion Subset n = 50,292
Portfolios of 5000 Observations With 688 Exact Zeros

Medium AF and Low Dispersion Subset n = 11405
Portfolios of 5000 Observations With 1,264 Exact Zeros

High AF and Low Dispersion Subset n = 145777
Portfolios of 5000 Observations With 1,468 Exact Zeros

Low AF and Medium Dispersion Subset n = 58,893
Portfolios of 5000 Observations With 675 Exact Zeros

Medium AF and Medium Dispersion Subset n = 95,113
Portfolios of 5000 Observations With 952 Exact Zeros

High AF and Medium Dispersion Subset n = 89,545
Portfolios of 5000 Observations With 730 Exact Zeros

Low AF and High Dispersion Subset n = 64,531
Portfolios of 5000 Observations With 771 Exact Zeros

Medium AF and High Dispersion Subset n = 76,768
Portfolios of 5000 Observations With 669 Exact Zeros

High AF and High Dispersion Subset n = 61,451
Portfolios of 5000 Observations With 362 Exact Zeros