How Do Analysts Interpret Management Range Forecasts?*

Michael Tang
mtang@stern.nyu.edu
Stern School of Business
New York University

Paul Zarowin
pzarowin@stern.nyu.edu
Stern School of Business
New York University

Li Zhang
lizhang@business.rutgers.edu
Rutgers Business School
Rutgers University

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ABSTRACT: Range forecasts have evolved to be the most common form of management forecasts. Prior studies typically use the midpoint to evaluate analyst reaction to range forecasts, implicitly assuming that analysts place equal weights on the upper and lower bounds of management range forecasts. We empirically test this restrictive assumption and provide strong evidence of unequal weights ─ analysts place significantly more (less) weight on the lower (upper) bound of forecast ranges. Moreover, such overweight on the lower bound is more pronounced when analysts face higher ambiguity, consistent with the "max-min" axiom, which predicts that decision-makers tend to assign higher probability to the worst-case scenario when facing ambiguity. Further tests show that "optimal revisions" with perfect foresight of actual earnings also overweight the lower bound.

Keywords: *Analyst forecast, management forecast, forecast revision, range forecast.*
Data Availability: *Data are commercially available.*

I. INTRODUCTION

Management earnings forecasts, also known as earnings guidance, play a significant role in capital markets (Ball and Shivakumar 2008; Beyer et al. 2010) that affects stock prices and bid-ask spreads (Pownall et al. 1993; Coller and Yohn 1997). In particular, a growing literature on "expectation management" examines how management forecasts establish and alter analyst earnings expectations (e.g., Ajinkya and Gift 1984; Waymire 1986; Baginski and Hassell 1990; Williams 1996; Matsumoto 2002; Cotter et al. 2006; Kross and Suk 2012; Rogers and Van Buskirk 2013). These studies usually regress analyst forecast revisions around a management forecast on the news conveyed from the management forecast. However, measuring forecast news can be difficult for range forecasts where managers provide both an upper bound and a lower bound of their earnings expectations. This issue becomes more important because range forecasts recently emerge as the most popular type of forecasts, accounting for around 80% of all management forecasts issued in the last decade (Ciconte et al. 2013), a sharp increase from under 20% in samples used in earlier studies (e.g., Pownall et al. 1993). This paper examines how analysts interpret management range forecasts.

Most prior studies typically use the mid-point to calculate forecast news, implicitly assuming that users of range forecasts such as analysts place equal weights on the upper and lower bounds of management range forecasts (Baginski et al. 1993).[1] A recent study by Ciconte et al. (2013) challenges this convention and examines whether the midpoint represents managers' true expectation – a question that is related to yet different from ours. Finding that the distribution of actual reported earnings is more concentrated around the upper bound of management range forecasts, they conclude that the upper bound is more likely than the

[1] In this paper, by "equal weights," we mean that the empirical sensitivity of analyst revision to the upper and lower bounds of management forecast ranges is "equal." We elaborate on this in our research design section.

midpoint to represent managers' true expectations. Although it is easy and natural to interpret range signals such as management range forecasts at a single point (regardless of whether the midpoint or the upper bound) based on some convenient "rule of thumb" (Tversky and Kahneman 1982), such an interpretation imposes a restrictive assumption, that is, 100% weight must be placed on a single point of the range, hence ignoring information conveyed by the entire forecast range. In this study we relax this restrictive assumption and empirically examine whether analysts place equal weights on the upper and lower bounds of range forecasts.

We evaluate the weights that analysts place on the upper and the lower bounds of range forecasts by regressing analyst forecast revisions on management forecast news conveyed from *both* the upper bound *and* lower bound of forecast ranges. The coefficient on each news measure reflects the relative weight that analysts place on the corresponding bound of the range. Because the upper and lower bounds are highly correlated (Pearson correlation = 0.8 in our sample), we modify our main empirical model by replacing one of the news measures with the range width, measured as the distance between the upper and lower bounds of forecast ranges, to mitigate the concern of multi-collinearity. After this modification, the coefficient on the range width captures the *differences* in the weights that analysts place on the upper and lower bounds of the forecast range. Under the null hypothesis implied in the extant studies that use the midpoint to compute management forecast news, we would expect the coefficient on the range width to be zero.

Contrary to this conventional implication, we predict that analysts place *unequal* weights, and that they place more weight on the lower bound of management range forecasts. Decision-making theories predict that ambiguity-averse agents tend to assign high probability to the worst scenario when they face ambiguity (Epstein and Schneider 2008). Hence, such decision-makers choose to maximize their expected utility assuming the worst scenario, so called "max-min" axiom proposed by Gilboa and Schmeidler (1989). Prior literature documents that analysts are less likely to cover firms in more uncertain environments or with less transparent disclosure (e.g., O'Brien and Bhushan 1990; Lang and Lundholm 1996), consistent with analysts being ambiguity averse. By indicating a range of possible future outcomes, management range forecasts deliver ambiguous signals to analysts. Therefore, we expect ambiguity-averse analysts to treat the worst-case scenario (i.e., the lower bound) as more likely than the best-case scenario (i.e., the upper bound). Moreover, we expect such differential treatment to be more pronounced as the degree of ambiguity increases.

Consistent with our expectations, we find that analysts place an average of 73% to 77% weight on the lower bound of management ranges forecasts, significantly more weight than on the upper bound. This effect is distinct from that of managers using range forecasts to "walk down" analyst expectations (e.g., Cotter et al. 2006) and also from the optimistic-to-pessimistic patterns observed in analyst forecasts as horizon decreases (e.g., Ke and Yu 2006). Results from various robustness tests further suggest that this effect is not driven by "bundled forecasts" – management forecasts that are simultaneously released with earnings announcements (Rogers and Van Buskirk 2013). Moreover, such overweight on the lower bound is more pronounced in scenarios where ambiguity or uncertainty is known to be higher, including when management forecasts are (a) issued earlier in the year, (b) issued with wider ranges, (c) issued by firms with higher analyst forecast dispersion, and (d) issued by firms with more volatile stock returns.

In supplemental tests, we find evidence that analysts adjust their weights based on the outcome of past range forecasts, consistent with the conjecture that analysts are "Bayesian" and learn from the past (Hillary et al. 2013). However, analysts' overweight on the lower bound of management range forecasts does not seem to be driven by their incentives to "lowball" their forecasts (Ke and Yu 2006; Hilary and Hsu 2012). Finally, using actual reported earnings to impute the "optimal" forecast revision by a hypothetical analyst with perfect foresight, we find consistent evidence that the "optimal" weight also lies more on the lower bound than on the upper bound. Hence analysts' overweight on the lower bound is indeed conducive to accurate prediction relative to equal weighting.

We caution readers to distinguish the "weight" from the "distance." Analysts' overweight on the lower bound does not necessarily mean that analysts' revised forecasts are "closer" to the lower bound. This is because analysts not only respond to management forecast news but also to managers' *provision* of the forecast *per se*, which is captured by the intercept of our analyst revision model. Existing theoretical (e.g., Grossman and Hart 1981) and empirical (e.g., Clement et al. 2003) studies suggest that managers' voluntary provision of earnings forecast is perceived as a desirable action. Consistent with this prediction, we find a positive intercept when we allow analysts to place unequal weights on the upper and lower bounds of range forecasts. However, the intercept turns negative when we follow the conventional design and force the weights to be equal. This finding demonstrates the importance of accounting for analysts' unequal weights when they respond to management range forecasts.

This study makes at least two contributions to the literature. First, it cautions researchers about the conventional practice of using the midpoint to interpret management range forecasts – an increasingly predominant form of management forecasts. This practice implicitly assumes that users of range forecasts place equal weights on both endpoints. We offer a simple and intuitive approach to assessing the relative weights on the endpoints of range forecasts, in the setting of analyst forecast revisions. Our findings reject the null hypothesis implied by the conventional approach and show that analysts place significantly more weight on the lower bound than on the upper bound of forecast ranges. To the best of our knowledge, the differential weights on the endpoints of range forecasts have never been investigated before in the literature. However, we emphasize that our approach is developed to examine how analysts interpret range forecasts and may not be appropriate or desirable in all range-forecast-related settings.[2] Nonetheless, future research on analyst reaction to management forecasts can follow this study and simply include the range width to relax the assumption of equal weights that is refuted by our findings.

Second, this study deepens our understanding of the growing literature on "expectation management", which focuses on the *average* effect of managers "walking down" analysts' expectations with management forecasts (e.g., Cotter et al. 2006; Kross and Suk 2012). These studies, however, ignore the *differential* effect of the upper and lower bounds of range forecasts on analyst expectations, as well as any *cross-sectional* variation in such differential effect. We document that analysts place more weight on the lower bound than on the upper bound, and this differential reaction is exacerbated when ambiguity is higher, consistent with the "max-min" axiom proposed in the decision-making literature (Gilboa and Schmeidler 1989; Epstein and Schneider 2008). Therefore, our paper contributes to the expectation management literature by introducing a new factor (ambiguity) through a new channel (analysts' differential weights on the upper and lower bounds of management range forecasts). This new channel is also relevant to managers that issue range forecasts, to analysts who use range forecasts, and to market participants who use analysts' forecasts.

Section II reviews related research and develops our hypotheses. In Section III we describe our sample. Section IV describes our empirical research design. We present our empirical results in Section V, and Section VI concludes.

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[2] In particular, we do not speak to whether the midpoint of management range forecasts should be used to measure forecast errors or forecast biases (Rogers and Stocken 2005; Gong et al. 2011), or whether the midpoint represents managers' true expectations (Ciconte et al. 2013).

II. RELATED RESEARCH AND HYPOTHESIS DEVELOPMENT

Management earnings forecasts typically take four forms – points, (closed-ended) ranges, maximums and minimums (also referred to as open-ended ranges), or qualitative forecasts – in decreasing order of precision. Earlier studies find mixed evidence on the effect of forecast form on market reaction (Baginski et al. 1993; Pownall et al. 1993). Notably, range forecasts have emerged as the predominant form of management forecasts from 6.8% in the 1980s (Pownall et al. 1993) to over 80% in recent years (Choi et al. 2010; Ciconte et al. 2013). Despite its popularity, little research exists on how analysts interpret range forecasts. Most studies treat range forecasts as equivalent to point forecasts at the midpoints (e.g., Rogers and Stocken 2005; Ajinkya et al. 2005; Feng and Koch 2010; Gong et al. 2011).

When managers issue a point forecast, only one number can serve as the benchmark against which analyst expectations can be measured. In contrast, a range forecast from managers expresses expectations in terms of both an upper and a lower limit, each of which can serve as a benchmark (Libby et al. 2006). Psychology research suggests that users of range estimates typically apply a simple "rule of thumb" and use the midpoint to interpret range estimates (Tversky and Kahneman 1982). Earlier empirical evidence also supports the use of midpoint to interpret management range forecasts because investors appear to respond most strongly to the midpoint of range forecasts (Baginski et al. 1993). Following this convention, most accounting studies use the midpoint to measure management forecast news in evaluating analysts' revisions in response to management forecasts (e.g., Feng and McVay 2010; Gong et al. 2011).

Ciconte et al. (2013) challenge this convention and seek to explore which point of the forecast range best represents managers' true expectations. Relative to the midpoint, they find the upper bound is more representative of managers' *ex ante* true beliefs, proxied by the *ex post* reported earnings. Their analysis of stock price reaction and analyst revision suggests that while investors' reaction is consistent with interpreting range forecasts near the upper bound, analysts seem to respond to the midpoint. Unlike this study, they use "distance" to evaluate which point of the range forecast is "closer" to analysts' revised forecasts, and do not consider the "weights" that analysts place on the endpoints of range forecasts, because their main focus is not on analysts' interpretation of management range forecasts.

Regardless of whether the upper bound or midpoint is more representative of managers' true expectations, we argue that analysts are unlikely to anchor on only a single point of a range forecast. An extensive body of psychology literature suggests that evaluations are made by comparisons to one or more reference points or standards (e.g., Thibaut and Kelley 1959; Helson 1964; Kahneman and Tversky 1979; Kida and Smith 1995; Thaler 1999). Following this literature, Libby et al. (2006) suggest that analysts use *both* the upper bound *and* the lower bound of management range forecasts as benchmarks to evaluate reported earnings, so-called the "benchmark effect." Responses from their analyst subjects are consistent with the "benchmark effect" of management range forecasts.

Building upon the "benchmark effect," we argue that analysts reacting to a management range forecast consider *both* the upper bound *and* the lower bound instead of a single point.[3] Therefore, both the upper and lower bounds of a management forecast convey news to the market relative to the preexisting expectations, which we refer to as "news upper" and "news lower" respectively. Moreover, analysts can respond to both news by assigning to them equal or unequal weights. If analysts place equal weights, then it is equivalent to them reacting to the midpoint of range forecasts, as is commonly used in prior studies. If analysts put all weight on

[3] Although analysts may form expectations over the entire range, unfortunately the distribution of their expectations is unobservable to researchers. Hence, we leave it to future research and focus only on the endpoints in this paper.

"news upper (lower)" and zero weight on "news lower (upper)," then it is equivalent to them reacting just to the upper (lower) bound. Unlike these approaches, which restrict the weights to be zero or fifty percent on the endpoints, we allow these weights to be determined empirically and to vary with economic determinants. Therefore our new approach is a more generalized framework which encompasses the existing approaches in the literature as its special cases.

Although the extant literature implicitly assumes that investors and analysts place equal weights on "news upper" and "news lower" (with the exception of Ciconte et al. 2013), we expect such weights to differ, with "news lower" being overweighed by analysts. Theories in the decision-making literature predict that ambiguity-averse agents are more likely to assign high probability to the worst scenario when they face ambiguity (Epstein and Schneider 2008). Hence such agents make choices that maximize their expected utility under the worst scenario, so called "max-min" axiom proposed by Gilboa and Schmeidler (1989). Prior studies find that analysts are less likely to cover firms in more volatile environments and with less transparent disclosure (O'Brien and Bhushan 1990; Lang and Lundholm 1996), consistent with analysts being ambiguity-averse. Management range forecasts deliver ambiguous signals to analysts, in the sense that a range of possible outcomes could be deemed as consistent with their forecasts. If analysts are ambiguity-averse on average, they will give more consideration to the worst-case scenario (e.g., the lower bound) than to the best-case scenario (e.g., the upper bound).[4]

H1: *Ceteris paribus*, when analysts revise earnings forecasts in response to management range forecasts, they place more weight on the news conveyed from the lower bound ("news lower") than on the news conveyed from the upper bound ("news upper").

[4] It is certainly possible that the worst (best) scenario could be some point below (above) the lower (upper) bound, but under the max-min framework, the same prediction would result about the unequal weights on the upper and lower bounds of management forecast range, that is, more weight would be placed on the lower bound, regardless of which two points outside of the range are selected to represent the best and worst scenarios.

Extending the "max-min" axiom, we expect analysts' relative overweight on the lower bound to be more pronounced when more ambiguity is present (Gilboa and Schmeidler 1989). Ambiguity can be manifested both in the properties of the management forecast itself and in the information environment. Specifically, forecasts issued earlier or with wider ranges are viewed as more ambiguous (Libby et al. 2006). Moreover, under heightened uncertainty, analysts tend to disagree with each other to a greater extent and hence analyst forecast dispersion is larger (Diether et al. 2002). Finally, stock price becomes more volatile when uncertainty is high (Bloom 2009). [5] This leads to our second set of empirical predictions.

H2: *Ceteris paribus*, when analysts revise earnings forecasts in response to a management range forecast, their overweight on the lower bound relative to the upper bound is more pronounced in the following scenarios:
(H2a) when the management forecast is provided earlier during the period;
(H2b) when the management forecast contains a wider range;
(H2c) when the dispersion of the preexisting analyst forecasts is larger; and
(H2d) when stock return volatility is higher.

III. SAMPLE SELECTION

We use First Call Company Issued Guideline (CIG) database to identify all management forecasts of annual earnings per share issued by U.S. firms between 1996 and 2011. We choose annual forecasts instead of quarterly forecasts for three reasons. First, the economic significance of differentiating between equal and unequal weights is greater for annual forecasts because their ranges are considerably wider than quarterly range forecasts.[6] Second, annual forecasts recently overtook quarterly forecasts in popularity due to both criticisms of quarterly forecasts (Houston et al. 2010; Chen et al. 2011) and increased frequency of updates of annual forecasts (Tang et al.

[5] It is also possible that analysts are "Bayesian" and hence adjust their weights on the upper and lower bounds of the management forecast range based on their previous experience. We defer this discussion to our empirical tests.
[6] The median (mode) range width is \$0.08 (\$0.10) for annual forecasts, compared with \$0.03 (\$0.02) for quarterly forecasts. Hence for an average quarterly range forecast, there is only about \$0.01 difference between the midpoint and the endpoint, rendering the equal/unequal weight a trivial issue in the setting of quarterly forecasts.

2014). Third, despite many recent papers that study management quarterly forecasts (e.g., Kross et al. 2011; Ciconte et al. 2013), annual forecasts remain an important setting in the management forecast literature (e.g., Rogers and Stocken 2005; Ajinkya et al. 2005; Gong et al. 2011; Hutton et al. 2012). Hence we focus on annual range forecasts. Following the literature, we exclude forecasts issued either before the previous year's earnings announcement ("long horizon forecasts") or after the end of the current fiscal year ("preannouncements"). We obtain non-split-adjusted actual earnings and analyst earnings forecasts from I/B/E/S. After eliminating duplicate forecasts and forecasts without valid identifiers or corresponding actual earnings, we arrive at a sample of 47,436 management annual earnings forecasts, which includes revisions within the fiscal year.

To assess the prevalence of range forecasts, we classify all forecasts into four types: point, range, max or min (open-range), and qualitative forecasts. Table 1 reports the yearly distribution by forecast types. The share of range forecasts increases from 36.5% in 1996 to a predominant 92.1% in 2011. Accordingly, the share of point forecasts decreases from 47.5% in 1996 to only 5.5% in 2011. Besides, the percentages of the other two types of forecasts also decline steadily over time, although a portion of this trend could be attributed to expansion of First Call's coverage of quantitative forecasts through time (Chuk et al. 2013). Nonetheless these trends highlight the importance of analyzing range forecasts. The emergence of range forecasts as the predominant form of management forecasts starts around the passage of Regulation Fair Disclosure (Reg FD) in late 2000, but the mean (median) range width remains roughly constant until 2007 when the financial crisis started, increasing from around $0.08 ~ $0.10 ($0.05 ~ $0.06) before the crisis to $0.11 ($0.09) and higher.

Table 2 presents the distribution of analyst consensus forecasts before management range forecasts (Panel A) and after management forecasts (Panel B), over five mutually exclusive cases with respect to the corresponding forecast ranges (Columns (a) through (e)): (-∞, Low), [Low, Mid), {Mid}, (Mid, High], and (High, +∞),where "Low," "Mid," and "High" indicates the lower bound, midpoint, and upper bound of management range forecasts, respectively. We present the distribution for the full sample as well as separately for each fiscal quarter. Prior to management forecasts (see Panel A), 29.4% (28.8%) of all analyst consensus forecasts are below (above) the entire forecast range, resulting in an asymmetry ratio of 1.021 around the entire forecast range. Similarly, within the range, 19.9% (18.8%) of all analyst consensus forecasts are below (above) the midpoint, leading to an asymmetry ratio of 1.036 around the midpoint.[7] While the asymmetry ratios are below one in the first quarter (Fq1) and above one in the remaining quarters (Fq2, Fq3, and Fq4), the overall ratios are close to one, suggesting that managers issue range forecasts roughly symmetrically around the prevailing analyst forecasts, with 41.8% of all management range forecasts containing the prevailing analyst consensus. Although only 34.1% of analysts' consensus forecasts in the fourth quarter (Fq4) are within management forecast ranges, this is partly because the forecast ranges are also narrower in the fourth quarter than in other quarters.

After management forecasts (Panel B in Table 2), the distribution of analyst consensus forecasts is notably different. 13.2% (20.4%) of all analyst consensus forecasts are below (above) the entire forecast range, resulting in an asymmetric ratio of 0.647 around the forecast range. Also within the range, 25.5% (33.8%) of all analyst consensus forecasts are below (above) the midpoint, leading to an asymmetry ratio of 0.714 around the midpoint. Both asymmetry ratios remain below one across all fiscal quarters, suggesting that analysts more often revise their

[7] This ratio should equal one for a symmetric distribution. A ratio smaller (greater) than one indicates that fewer (more) observations are below rather than above the range or the midpoint.

forecasts above the midpoint, consistent with the finding in Ciconte et al. (2013). Overall 66.4% of all analysts' revised consensus forecasts are within the management forecast range, with over half of them (33.8% of total) in the upper half of managers' forecast range (Column (d)). The apparently different distributions of analyst consensus forecasts between before and after management forecasts suggest that analysts react to management forecasts. The wide distribution of analyst revised forecasts over management forecast ranges implies that analysts respond not just to the midpoint. Below we develop our empirical design to investigate how analysts interpret management range forecasts.

IV. EMPIRICAL RESEARCH DESIGN

Assume that θ is the hypothetical weight that an analyst places on the upper bound of a management range forecast and hence $1-\theta$ is the weight placed on the lower bound.[8] Thus the news conveyed by a management range forecast can be expressed as $\theta * Upper\ Bound_{i,t} + (1-\theta) * Lower\ Bound_{i,t} - AF_{i,t-1}$, where *Upper Bound* and *Lower Bound* are the upper and lower bounds of management forecast ranges, and *AF* is the prevailing analyst consensus forecast prior to the management forecast. For each management forecast, we collect analysts' last forecasts issued within 30 days before the management forecast date and use the median analyst forecast as the consensus analyst forecast. To examine the relative weights that analysts place on the upper and lower bounds of management range forecasts in revising their own forecasts, we estimate the following model using ordinary least squares (OLS) regression.

$$Revision_{i,t} = a + b[\theta * Upper\ Bound_{i,t} + (1-\theta) * Lower\ Bound_{i,t} - AF_{i,t-1}] + \varepsilon \qquad (1)$$

[8] In our baseline model, we parsimoniously treat θ as a constant, but in later analyses, we allow θ to be a function of various economic factors, including historical outcomes to allow analysts to be "Bayesian."

where *Revision* is mean analyst forecast revision around a management forecast, calculated as analysts' first forecasts within 30 days after the management forecast minus their last forecasts within 30 days before the management forecast, scaled by the closing price at the end of the prior year.[9] Accordingly we also scale forecast news by the closing price at the end of the prior year.[10] Observations are deleted if the stock price is less than $1 to mitigate small denominator problems.

Our focus in Model (1) above is whether θ is less than 0.5, as our H1 predicts analysts to underweight the upper bound of range forecasts. Note that if we force θ to be 0.5, then Model (1) degenerates into a model using the midpoint of management forecast to calculate management forecast news, as is commonly used in the existing literature (e.g., Ajinkya et al. 2005; Rogers and Stocken 2005; Gong et al. 2011; Rogers and Van Buskirk 2013). By allowing θ to be estimated from the regression, we can statistically validate the assumption that $\theta = 0.5$. However, because in a panel sample, the upper and lower bounds of range forecasts are highly correlated, directly estimating Model (1) suffers from severe multi-collinearity problem (Wooldridge 2002). To circumvent the problem we rearrange the right-hand side of Model (1) by considering the fact that *Upper/Lower Bound = Midpoint +/- 0.5*Width*, where *Width* is width of management range forecast and *Midpoint* is the midpoint of management range forecast. After rearrangement, we obtain the following model:

$$Revision_{i,t} = a + b(News\_Mid_{i,t}) + b(\theta - 0.5) * Width_{i,t} + \varepsilon \qquad (1M)$$[11]

[9] Our results are robust to using either the mean or the median analyst forecasts for *AF* and *Revision*. Extending the revision window to +/- 60 days does not change our inferences either.

[10] We follow prior studies to price-deflate our regression variables (e.g., Gong et al. 2011), but our results are robust to using the magnitude of forecasted earnings as an alternative deflator, or to deflating the intercept in the regression model.

[11] Note that from Model (1) to Model (1M) is pure algebra rearrangement, and hence the coefficient *b* and parameter θ should remain the same. However, this equality and hence the relation between *b* and θ implied from the ratio of the regression coefficients will no longer hold if we also include an interaction term *News_Mid* × *Width* as in prior studies (e.g., Baginski et al. 2011). To see this, consider the coefficient *b* in Model (1M) as analysts' reaction to the midpoint of *any* range forecast. However, once the interaction term *News_Mid* × *Width* is included in the model, the coefficient on *News_Mid* becomes analysts' reaction to the midpoint of range forecasts *with a zero width*.

where *News_Mid* is management forecast news calculated as the midpoint minus the prevailing analyst consensus before management forecast, scaled by the closing price at the end of the prior year.

Our baseline approach is the following. Because the ratio of the coefficient on *Width* divided by the coefficient on *News_Mid* is a univariate function of θ, we can infer θ from the coefficient estimates from the regression results of Model (1M). If analysts place equal weights on the upper and lower bounds ($\theta = 0.5$), the ratio of the coefficient on *Width* divided by the coefficient on *News_Mid* in Model (1M) should be statistically indifferent from zero.

To examine cross-sectional variations in the relative weights analysts place on the upper and lower bounds of management forecasts, we interact forecast width (*Width*) with variables that capture firm characteristics and the properties of management forecasts. By doing so, we allow θ to be a function of these variables. If analysts adjust their weights on the upper and lower bounds according to these variables, these interaction terms should be significant in explaining analyst forecast revisions. Our H2 predicts that such variables include the fiscal quarter in which the management forecast occurs (*Fq1*, *Fq2*, and *Fq3*), forecast range width of the management forecast (*Range*), analyst forecast dispersion (*Dispersion*), and stock return volatility (*RetVol*). More detailed definitions are elaborated in the Appendix.

In our additional analysis, we evaluate the "optimal" weights on the upper and lower bounds of forecast ranges that lead to the perfect prediction of actual reported earnings. To do so, we compute the "optimal revision" as the actual earnings minus the prevailing analyst consensus forecast prior to the management forecast, scaled by the closing price at the end of the prior year, which is labeled as *AFE_PRE*. We replace the dependent variable in Model (1) with *AFE_PRE* to assess the optimal weights that analysts would place on the upper and lower bounds if their revisions can perfectly predict actual earnings.

V. EMPIRICAL RESULTS

Descriptive Statistics

Table 3 Panel A presents the descriptive statistics of the variables used in our empirical models. Our sample size reduces to 10,989 due to missing data for analyst forecasts within 30 days before and after management range forecasts.[12] The mean (median) of *Revision* is -0.053% (0.039%) of the share price, suggesting that analysts more often revise their forecasts upward than downward after management range forecasts, but the average magnitude of downward revision exceeds that of upward revision (t = -8.67, untabulated). In contrast, the magnitude of *AFE_PRE* (our measure of the optimal revision) is greater than that of *Revision*, suggesting that analysts on average only partially correct their initial forecast errors. This partial correction, however, should not affect the relative weights analysts place on the endpoints of management range forecasts, for the reasons we explained earlier (see footnote 9). The median of *News_Mid* is 0, consistent with our results in Table 2 Panel A that the prevailing analyst consensus forecasts is nearly symmetric around the midpoint of management range forecasts. The mean (median) *Width* is 0.406% (0.279%) of the share price. For the 9,062 management range forecasts that are bundled with earnings announcements, the bundled earnings news (*Bundle_Eanews*) has a mean (median) of 0.082% (0.062%).

Table 3 Panel B presents the univariate Pearson correlations among the variables. Values in boldface are significant at the 1% level. *Revision* is positively correlated with *News_Mid* (ρ=

[12] The requirement of the [-30, +30] window is to ensure that analysts' revisions are driven by management forecasts. Results are qualitatively the same if we relax the window to [-60, +60] to obtain a bigger sample size of 15,122.

0.785), suggesting that management forecasts affect analyst revisions (e.g., Cotter et al. 2006). *Upper Bound* and *Lower Bound* are highly correlated (ρ=0.803 untabulated), which confirms our concern of multi-collinearity if both these variables are included in the same regression. *Width* is only moderately correlated with *News_Mid* (ρ= -0.114), thus mitigating multi-collinearity when it is used in place of both *Upper Bound* and *Lower Bound*.

Analysts' Weights on the Upper and Lower Bounds of Management Range Forecasts (H1)

Table 4 presents our primary results. The standard errors are robust and clustered by firm. In Column (1), we follow prior literature and measure management forecast news using the midpoint (*News_Mid*), which implicitly forces analysts' weights to be equal on the upper bound and lower bound of management forecast ranges. Consistent with prior literature, *News_Mid* is significantly positive (t = 55.05), suggesting that analysts react strongly to management forecast news. Note that the intercept in Column (1) is significantly negative (t = -3.25), which implies that analysts on average react negatively to the *action* of management forecasts. This suggests that analysts would revise forecasts downward even when the midpoint of a management forecast coincides with their prevailing consensus (i.e., *News_Mid = 0*), which contradicts the notion that voluntary disclosure of confirming forecasts is typically viewed positively because it reduces uncertainty about future earnings (Clement et al. 2003), and is also inconsistent with the prior findings that investors and analysts on average prefer more management disclosures (Lang and Lundholm 1993; Bushee and Noe 1999).[13]

Importantly, the negative intercept reverses to positive once we allow analysts to place *un*equal weights on the upper and lower bounds of management forecast ranges by including

[13] The positive effect of the mere act of providing voluntary disclosure is two-fold. First, investors will only dismiss the belief that the firm is hiding the worst news when they receive a disclosure, regardless of the content (Grossman and Hart 1981). Second, the disclosure itself reduces uncertainty about the future (Clement et al. 2003).

forecast width (*Width*) in Model (1M), as the intercept in Column (2) is significantly positive (t=8.00), suggesting that analysts positively perceive managers' action of providing forecasts, consistent with analysts favoring more disclosure (Lang and Lundholm 1993). Therefore, the puzzling result in Column (1) is likely due to the empirical design that fails to allow analysts to place unequal weights on the upper and lower bounds of management range forecasts.

Results in Column (2) provide evidence that the weights are indeed unequal. Recall that θ is the hypothetical weight that analysts place on the upper bound when revising forecasts. If analysts weigh the upper and lower bounds equally ($\theta = 0.5$), the coefficient on *Width* divided by the coefficient on *News_Mid*, which is expected to equal $\theta - 0.5$, should be statistically indifferent from zero. Contrary to this prediction, the estimated coefficient ratio is significantly negative at -0.229 (t= -8.24), rejecting the null hypothesis that analysts place equal weights on the upper and lower bounds of management forecast ranges when revising their own forecasts. Our regression coefficients imply that analysts place 0.271 weight on the upper bound of management forecasts, thus 0.729 (= 1 - 0.271) weight on the lower bound, when responding to range forecasts.[14]

Next in Columns (3) and (4), we follow Gong et al. (2011) and include industry and year fixed effects in our Base Model and Model (1M), to account for industry-specific effects and any temporal trend.[15] The inclusion of fixed effects renders the intercept uninformative of analysts' response to managers' action of providing forecasts. The coefficient ratio in Column (4) implies that analysts place a weight of 0.244 on the upper bound, significantly less than 0.5 (t= -8.71), consistent with our hypothesis H1 that analysts respond to a management range forecast (a signal

[14] Despite concerns of multi-collinearity, in an untabulated test, we regress *Revision* on news measured from both the *Upper Bound* and *Lower Bound*, and we continue to find a positive intercept (t=7.02) and $\theta - 0.5$ significantly negative (t=-7.44).

[15] For the same reason, we include industry and year fixed effects in all our remaining analyses.

of ambiguity) by overweighting the lower bound (treating the worst scenario as more likely than the best scenario).

The strong and consistent evidence that analysts place *unequal* weight on the upper and the lower bounds of management range forecasts is important to researchers, given its sharp contrast from the implicit assumption of "equal weights" from the conventional research design that uses the midpoint to measure forecast news in studying analyst reaction to management forecasts (e.g. Ajinkya et al. 2005; Rogers and Stocken 2005; Gong et al. 2011; Rogers and Van Buskirk 2013). To relax the "equal weight" assumption, which is refuted by our evidence, future studies should at least include *Width* in the analyst revision model to allow analysts to place unequal weights on the endpoints of management range forecasts.

We also emphasize and caution readers to distinguish the "weight" from the "distance." Analysts' overweight on the lower bound does not conflict with our previous result in Table 2 that analysts' revised forecasts are actually "closer" to the upper bound (also see Ciconte et al. 2013). Recall that the "weight" is the empirical sensitivity of analyst forecast revision to the forecast news conveyed from management forecast endpoints. Therefore, even though analyst forecast revision is more sensitive to the lower bound of management range forecasts, analysts respond positively to managers' action of providing forecasts (evidenced by a positive intercept in Column (2)), resulting in the revised forecasts actually above the midpoint.

Overall, the results in Table 4 provide strong evidence that analysts place unequal weight on the upper and lower bounds of management range forecasts, with significantly more weight placed on the lower bound than on the upper bound, consistent with the prediction of H1.

Addressing Concerns of Management Forecasts Bundled with Earnings Announcements

Because our dependent variable – analysts forecast revision – can be affected also by any concurrent release of information with management forecasts, we conduct a battery of analyses to mitigate the impact of the most common concurrent information – bundled earnings news (e.g., Rogers and Van Buskirk 2013). The results are presented in Table 5.

In Column (1), we directly control for the bundled earnings news. The implied θ is 0.197 and remains significantly less than 0.5 (t= -9.72). In Column (2), we exclude all "bundled" management forecasts and retain only "stand-alone" forecasts, reducing the sample size to 1,927. The implied θ is 0.060 and remains significantly less than 0.5 (t= -4.91). In Column (3), we restrict the sample to only bundled forecasts, and the implied θ is 0.217 and remains significantly less than 0.5 (t= -8.90). Next we separate forecasts bundled with positive earnings news (*Bundle_Eanews ≥0* in Column (4)) from forecasts bundled with negative earnings news (*Bundle_Eanews <0* in Column (5)). In both cases, the implied θ remains significantly less than 0.5 (t= -7.85 and -5.57). In Column (6), we follow the procedure described in Rogers and Van Buskirk (2013) to calculate analysts' predicted revision in response to bundled earnings news, and measure management forecast news against this predicted analysts' revised forecasts. The implied θ is 0.218 and remains significantly less than 0.5 (t= -3.15). However, the sample size is substantially reduced due to the requirement of additional variables, limiting the testing power. Therefore, we choose to directly control for bundled earnings news in our remaining analyses.

Overall, our finding that analysts overweight the lower bound of management forecasts is robust to a battery of tests that mitigate the confounding effect of "bundled" earnings news.

Cross-Sectional Variations in Analysts' Weights on Management Forecast Bounds (H2)

Results in Tables 3 and 4 suggest that, on average, analysts place more weight on the lower bound than on the upper bound of management range forecasts. However, we expect the degree of such unequal weight to differ across subsamples. Specifically, if analysts' overweight on the lower bound is a result of following the "max-min" axiom of decision making behavior, then we expect the overweight on the lower bound to be more pronounced when uncertainty is higher, predicted in our H2. To examine this prediction, we re-estimate Model (1M), interacting *Width* with different measures of uncertainty, in the following form.

$$Revision_{i,t} = \beta_0 + \beta_1 (News\_Mid_{i,t}) + \beta_2 Width_{i,t} + \beta_3 (Width_{i,t} * X_{i,t}) + \beta_4 X_{i,t} + \beta_5 Bundle\_Eanews + \varepsilon \quad (2)$$[16]

where *X* is the variable that we expect to change analysts' relative weights on the upper and the lower bounds of management forecast ranges.

If analysts increase (decrease) their relative overweight on the lower bound when *X* takes a higher value, we expect the coefficient on the corresponding interaction term to be significantly negative (positive).[17] For ease of interpreting the results, we transform continuous variables into indicator variables that are set to one for observations above sample medians and zero otherwise. Hence the coefficient on *Width* in Model (2) is ($\beta_2 + \beta_3$X), which should be equal to $b^*(\theta-0.5)$ as in Model (1M). Drawing from Model (1M), the coefficient ratio of ($\beta_2 + \beta_3$X) /β_1 in Model (2) should be equal to $\theta-0.5$, which allows θ to be a function of X. For observations where X =0, the implied $\theta_{X=0} = \beta_2/\beta_1 + 0.5$, whereas for observations where X = 1, the implied $\theta_{X=1} = (\beta_2 + \beta_3)/\beta_1 + 0.5$; the difference in the implied $\Delta\theta = \theta_{X=1} - \theta_{X=0} = \beta_3/\beta_1$.

[16] Although we do not expect the coefficient on News_Mid to vary with X, nevertheless, in untabulated tests, we also control for the interaction of *X* with *News_Mid* and obtain qualitatively similar results.

[17] Note that we are comparing the weight analysts put on the lower bound in the cross-sectional analyses, although on average analysts still place less weight on the upper bound than on the lower bound (i.e., θ <0.5) in most cases.

The results are reported in Table 6. In Column (1), we test our H2a and examine whether analysts increase their weight on the lower bound of forecasts issued in earlier quarters, indicated by three dummy variables for the first, second, and third quarter (*Fq1*, *Fq2*, and *Fq3*), using the fourth quarter as the benchmark. The coefficient on the interaction term *Width*Fq1* is negative and significant at -0.144 (t= -3.03), suggesting that analysts overweight the lower bound to a larger extent in the first quarter than in the fourth quarter. Using the coefficients to infer analysts' weight on the lower bound (θ), analysts add another 0.204 weight on the lower bound in the first quarter than in the fourth quarter. Because earlier forecasts tend to contain higher uncertainty, this finding is consistent with analysts shifting more weight on the worse scenario as they face more uncertainty, which is consistent with the "max-min" axiom (Gilboa and Schmeidler 1989). The interaction terms *Width*Fq2* and *Width*Fq3* are negative but not significant (t= -1.26 and -0.36), but the standalone term *Width* is significantly negative (t= -4.19), suggesting that analysts still overweight the lower bound even when management forecast is issued in the fourth quarter, when uncertainty about the annual earnings is the lowest.

In Column (2), we test our H2b and examine whether analysts increase their weight on the lower bound of forecasts with wider ranges (*D_WideRange* is set to one if *Width* is larger than the median). Consistent with this prediction, the coefficient on the interaction term *Width*X* is negative and significant at -0.110 (t= -2.02). The coefficients imply that analysts shift additional weight of 0.155 from the upper bound to the lower bound when management range forecasts are wider, even though the weight is already significantly less than 0.5 on the upper bound (t= -2.31) for narrow ranges. This finding is consistent with analysts viewing wider range forecasts as more uncertain and shift even more weight on the lower bound, consistent with the "max-min" axiom (Gilboa and Schmeidler 1989).

Both Columns (1) and (2) of Table 6 examine the uncertainty conveyed by the properties of management forecasts, that is, the timing and the range width. Next we examine whether uncertainty reflected in the information environment also affects analysts' weight on the endpoints of management range forecasts. We use analyst forecast dispersion and return volatility as measures of information uncertainty following prior literature (e.g., Feng and Koch 2010; Chen et al. 2011) and report the results in Columns (3) and (4). Consistent with our H2c and H2d, we find that analysts further reduce weights on the upper bound when facing higher uncertainty as the interaction terms are significantly negative (t= -3.99 and -4.53). Moreover, the coefficient on *Width* remains significantly negative (t= -3.14 and -1.85), suggesting that even when the information environment contains relatively little uncertainty, analysts still view range forecasts from managers as ambiguous signals and overweight the lower bound, consistent with the "max-min" axiom.

Are Analysts "Bayesian" and Learn from the Past?

We next investigate whether analysts are "Bayesian" in the sense that they adjust their weights on management forecast bounds based on past experience. Two reasons motivate this analysis. First, many managers provide earnings forecasts regularly (e.g., Rogers et al. 2009; Tang 2013), thus providing the opportunity for analysts to learn from past management forecasts (Hilary and Shen 2013). Second, prior literature also provides evidence consistent with analysts facing parameter uncertainty and learning rationally about the parameters over time (Markov and Tamayo 2006). Table 7 presents the results from this analysis.

First, if actual earnings were closer to the upper bound than to the lower bound of management forecast in the previous year (*D_LastActualCloserToUpper=1*), a "Bayesian" analyst is likely to shift more weight from the lower bound to the upper bound. To ensure that the current management forecast is comparable to that in the previous year, we require them to be issued in the same quarter, which reduces the sample size to 7,617. In Column (1), we find a marginally significant and positive coefficient on the interaction term (t= 1.73), providing some evidence that analysts place more weight on the range endpoint that was previously proven to be more accurate. Importantly, the coefficients continue to imply a weight of less than 0.5 on the upper bound (0.170+0.113 =0.283) even when the actual earnings were closer to the upper bound in the previous year, consistent with our main hypothesis.

Next, in Column (2), we examine whether analysts compare the range width with past forecasts and adjust their weights accordingly. If the current forecast is wider than that in the same quarter in the previous year (*D_WiderThanLast=1*), we find that analysts shift significantly more weight from the upper bound to the lower bound, as the interaction term is significantly negative (t= -7.95). This result shows that as uncertainty increases, the weight on the lower bound increases. This is consistent with the results in Table 6, where uncertainty is measured in the cross section, whereas in Table 7 uncertainty is measured with respect to each firm's own time series, both of which are consistent with the max-min axiom.

Taken together, Columns (1) and (2) in Table 7 provide evidence that analysts are Bayesian and learn from past experience. While we find some evidence that analysts adjust their weights based on whether actual earnings were closer to the upper or lower bound, we find strong evidence that their overweight on the lower bound is more pronounced when the current forecast range is wider than before, consistent with the "max-min" explanation.

Does "Lowballing" Explain Analysts' Overweight on the Lower Bound?

Prior research suggests that analysts have incentives to "lowball" their forecasts so that managers could meet or beat their forecasts more easily and possibly return the favor with more private communication (Ke and Yu 2006; Hilary and Hsu 2012). However, analysts also want to avoid issuing forecasts that are too gloomy because poor expectations could hurt the firm's stock price and anger managers to limit the analysts' access to management (Brown et al. 2013). It is possible that management range forecasts offer the lower bound as an apparent target for analysts to "lowball" their forecasts. To evaluate this explanation, we examine whether analysts' overweight on the lower bound becomes more pronounced when "meeting and beating" analysts' forecasts is more important to managers, who therefore are more likely to favor analysts issuing "low ball" forecasts (Hilary and Hsu 2012). Prior literature suggests that managers have stronger incentives to meet and beat analyst forecasts if they have done so in the recent past (Kross et al. 2011). Therefore, if the actual earnings met or beat analyst consensus forecasts in the previous year (*D_MeetAF=1*), we would expect analysts to overweight the lower bound to a greater extent if "low balling" is the primary reason for them to overweight the lower bound. We report the results in Column (3) of Table 7 and the interaction term is insignificant (t= 0.13). Therefore, we do not find evidence that they overweight the lower bound more when the incentive to "low ball" forecasts is stronger.

Related to analysts' incentives to "lowball" their forecasts, it has been documented that managers often use earnings forecasts to "walk down" analyst forecasts (e.g., Matsumoto 2002; Cotter et al. 2006). To examine whether our result of analysts' overweight on the lower bound is driven by managers "walking down" analyst expectation, we define a dummy variable for "guide -down" guidance (*D_GuideDown*), which is set equal to one if the entire range of management forecasts fall below the prevailing analyst consensus, and zero otherwise.[18] If our result is driven by managers' guiding down analyst forecasts, then we would expect the overweight on the lower

[18] Our results remain qualitatively the same if we define *D_GuideDown* as one if the midpoint of the range forecast (rather than the entire range) is below the prevailing analyst consensus forecast, and zero otherwise.

bound to be more pronounced for “guide-down” forecasts and hence the interaction term of *D_ Guidedown* and *Width* should be negative. The result, reported in Column (4) in Table 7, shows that the interaction is insignificant (t = -0.85). Therefore, we do not find evidence that analysts’ overweight on the lower bound is more pronounced when management forecasts “walk down” analyst expectations. Note that the coefficient on *Width* remains significantly negative (t= -9.16), suggesting that even when management forecasts do not “walk down” analyst expectation, analysts still overweight the lower bound as θ is significantly less than 0.5 (t= -8.84).

To summarize, in Table 7 Columns (3) and (4), we do not find evidence that analysts’ overweight on the lower bound of management range forecasts is more pronounced when they have stronger incentives to “lowball” their forecasts, proxied by recent success of managers meeting or beating analyst forecasts and by managers’ explicit “guide-down” forecasts. These results suggest that our finding of analysts’ overweight on the lower bound of management range forecasts is distinct from the documented phenomena of analysts “lowballing” their forecasts and managers’ “walking down” analyst expectation (e.g., Matsumoto 2002; Ke and Yu 2006; Cotter et al. 2006; Hilary and Hsu 2012). While these phenomena focus on the “distance” of analysts’ forecasts to management forecasts or to actual earnings, our focus is on the “weight” of analyst forecast revision on the upper and lower bounds of management range forecasts.

Optimal Weights on Management Forecast Bounds

So far we have documented strong and robust evidence that analysts place significantly more weight on the lower bound of management range forecasts and that such overweight on the lower bound is stronger when uncertainty is higher. However, it is unclear whether overweighting the lower bound of management range forecasts leads to more accurate forecast revisions. To investigate this, we estimate the “optimal weights” on the upper and lower bounds of management forecast ranges assuming perfect foresight of the actual reported earnings is available to analysts. Therefore, we replace the dependent variable in the previous models with *AFE_PRE*, measured as the actual earnings minus the consensus analyst forecast prior to the management forecast, deflated by the beginning stock price. If analysts could forecast earnings accurately with perfect foresight, then the optimal weight they place on the lower bound should be consistent with the θ implied from the *AFE_PRE* regression reported in Table 8. We admit that analysts have imperfect information about actual reported earnings; hence we do not expect analysts' weights in Table 4 to be perfectly aligned with the "optimal weights" in Table 8. The purpose of this analysis is rather to answer the following question: *compared with* placing equal weights on the upper and lower bounds of management range forecasts, as implied in the extant research, is analysts' overweight on the lower bound *qualitatively* consistent with the optimal weight implied from actual reported earnings? If so, we expect the implied θ in the *AFE_PRE* regression to be significantly less than 0.5.

Table 8 reports the results on "optimal weights" in the same format as in Table 5, which accounts for bundled earnings news. Across all specifications, the optimal weight on the upper bound implied from actual earnings is significantly less than 0.5 with t-stats ranging between -3.82 and -6.27, thus rejecting the null hypothesis that equal weights on the upper and lower bounds of management range forecasts should be the optimal weights, as implicitly assumed in the existing research design in empirical accounting literature.

In summary, using actual reported earnings to compute "optimal revisions", we find evidence that the "optimal weight" is also significantly higher on the lower bound. Therefore, analysts' overweight on the lower bound of management range forecasts leads to more accurate revisions than if they place equal weights on management forecast bounds.

Additional Tests and Robustness Checks

Throughout the paper, we use the revision in analysts' consensus forecasts, because we are interested in whether the average analysts place equal weights on the upper and lower bounds of management range forecasts. In untabulated tests, we alternatively measure *Revision* using the highest or the lowest analyst forecast minus the preexisting consensus, and obtain qualitatively the same results that analysts' weight on the lower bound is significantly more than 0.5 (t-stat= 3.94 and 12.60 respectively).[19]

Another possible explanation for analysts to overweight one endpoint over another is that they might place more weight on the bound that is closer to their prevailing consensus, because psychology research suggests that people tend to interpret information in a biased way that confirms their existing expectations, so-called "confirmation bias" (Lord et al. 1979). We investigate this explanation by estimating analysts' weight on the lower bound separately for forecasts that are above the prevailing consensus (where the lower bound is closer to current expectation) and for forecasts that are below the prevailing consensus (where the upper bound is closer to current expectation). In both cases, we continue to find analysts' weight on the lower bound significantly higher than 0.5 (t-stats = -8.13 and -6.39 respectively).

Finally, we assess whether macro-economic conditions play a role in analysts' weight on management forecast bounds. Following NBER's definition of recessions, we find that analysts' weight on the upper bound is lower during recessions ($\theta = 0.098$) than during expansions ($\theta = 0.308$), although both are significantly less than 0.5 (t-stats= -7.59 and -5.05 respectively). To the extent that uncertainty tends to be higher during recessions, this finding is consistent with our H2 that heightened uncertainty exacerbates analysts' overweight on the lower bound.

[19] As an additional robustness check, we follow Gu and Wu (2003) and include the skewness of earnings to account for the possibility that analysts may aim to forecast the median rather than the mean of earnings. Our result from this analysis is qualitatively the same as our main result.

VI. CONCLUSION

Range forecasts have evolved to be the most common form of management forecasts. Most prior studies use the midpoint to evaluate analyst reaction to range forecasts, implicitly assuming that analysts place equal weights on the upper and lower bounds of management range forecasts. In this study, we relax this restrictive assumption and find strong empirical evidence of unequal weights: analysts place significantly more weight on the lower bound than on the upper bound of management forecast ranges. Moreover, analysts' overweight on the lower bound is more pronounced when ambiguity is higher, consistent with the "max-min" axiom that decision-makers facing ambiguity tend to assign higher probability to the worst-case scenario. Our results are robust to a host of tests controlling for "bundled" earnings news (Rogers and Van Buskirk 2013) and are distinct from the documented phenomena of analysts "lowballing" their forecasts or managers "walking down" analyst expectations (Cotter et al. 2006). Analysts also appear to be "Bayesian" and overweight the lower bound to a greater extent when facing range forecasts that are wider than before. Additional analyses show that "optimal revisions" with perfect foresight of actual earnings also overweight the lower bound, suggesting that analysts' overweight on the lower bound of management range forecasts facilitates accurate forecasting compared with placing equal weights on management forecast bounds.

Our study is of interest to managers that issue range forecasts, to investors and analysts who use range forecasts, and to the growing literature on expectation management that examines analyst reactions to management forecasts. Building upon analysts' unequal weights placed on the upper and lower bounds of management range forecasts, future studies can further explore whether the accuracy and credibility of management range forecasts can affect analysts' unequal weights on the forecast bounds.

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APPENDIX
Variable Name and Definition

Dependent Variables:

Revision = the mean revision of all analysts that issue forecasts both before and after a management forecast, deflated by the stock price at the beginning of the year.

AFE_PRE = the difference between the actual earnings and the median analyst earnings forecast prior to a management range forecast, deflated by the stock price at the beginning of the year.

Independent Variables:

News_Mid = the midpoint of a management range forecast minus the prevailing consensus analyst forecast, deflated by the stock price at the beginning of the year.

Width = the distance between the upper bound and the lower bound of a management range forecast, deflated by the stock price at the beginning of the year.

Bundle_Eanews = the actual earnings announced along with a management range forecast minus the median analyst forecast for the actual earnings, deflated by the stock price at the beginning of the year.

Fq1 = an indicator variable set to one if a management forecast is issued in the first fiscal quarter, and zero otherwise.

Fq2 = an indicator variable set to one if a management forecast is issued in the second fiscal quarter, and zero otherwise.

Fq3 = an indicator variable set to one if a management forecast is issued in the third fiscal quarter, and zero otherwise.

D_WideRange = an indicator variable set to one if the width of management forecast range is higher than the median, and zero otherwise.

D_Dispersion = an indicator variable set to one if *Dispersion* is higher than the median, and zero otherwise, *Dispersion* is the standard deviation of analyst forecasts issued within 90 days before the management forecast announcement.

D_RetVol = an indicator variable set to one if *RetVol* is higher than the median, and zero otherwise, where *RetVol* is the stock return volatility measured as the standard deviation of daily stock return from day -120 to day -1 relative to the management forecast date.

D_LastActualClosertoUpper = an indicator variable set to one if the previous year's actual earnings are closer to the upper bound of the management forecast issued in the same quarter of the previous year, and zero otherwise.

D_WiderThanLast = an indicator variable set to one if the current range forecast width is wider than the range width of the management forecast issued in the same quarter of the previous year, and zero otherwise.

D_MeetAF = an indicator variable set to one if a company's actual earnings meet analysts' consensus in the previous year, and zero otherwise.

D_GuideDown = an indicator variable set to one if the upper bound of a management range forecast is lower than the prevailing analyst consensus, and zero otherwise.

TABLE 1: Annual Distribution of Forecast Types

All Annual Management Forecasts						Range Forecast Width		
Year	**N**	**Point**	**Range**	**Open**	**Quali-tative**	**Mean**	**Median**	**Std**
1996	301	47.5%	36.5%	10.3%	5.6%	0.085	0.060	0.076
1997	453	46.6%	30.0%	12.8%	10.6%	0.103	0.060	0.126
1998	814	45.7%	28.0%	7.1%	19.2%	0.087	0.050	0.084
1999	1,126	32.8%	30.0%	12.1%	25.1%	0.092	0.050	0.165
2000	1,166	33.5%	40.2%	8.3%	17.9%	0.079	0.050	0.153
2001	2,659	21.4%	66.7%	5.1%	6.8%	0.088	0.050	0.083
2002	3,582	17.5%	75.5%	4.0%	3.0%	0.087	0.050	0.085
2003	3,954	13.4%	79.2%	4.6%	2.9%	0.093	0.060	0.101
2004	4,630	10.4%	83.2%	3.8%	2.6%	0.096	0.060	0.109
2005	4,539	9.2%	87.9%	2.4%	0.5%	0.097	0.060	0.105
2006	4,861	9.4%	88.0%	1.6%	0.9%	0.104	0.080	0.106
2007	4,508	10.2%	87.6%	1.6%	0.6%	0.108	0.090	0.105
2008	4,491	10.6%	86.8%	2.6%	0.0%	0.121	0.100	0.111
2009	3,498	8.9%	89.1%	2.0%	0.0%	0.149	0.100	0.142
2010	3,955	7.1%	90.5%	2.4%	0.0%	0.133	0.100	0.122
2011	2,899	5.5%	92.1%	2.5%	0.0%	0.144	0.100	0.132
Total	**47,436**	**13.2%**	**80.6%**	**3.4%**	**2.8%**	**0.110**	**0.080**	**0.114**

Note: This table presents the relative frequency of management forecasts by form: point, range, open-ended range (max/min), and qualitative. The sample is constructed based on the First Call Company Issued Guideline (CIG) database and contains management forecasts for annual earnings of fiscal years between 1996 and 2011. For all management range forecasts in each year, we also report the distribution of range widths, measured as the distance between the upper bound and the lower bound of management range forecasts.

TABLE 2 – The Location of Analyst Consensus Forecasts with Regard to Management Forecast Ranges

Panel A: Analyst Consensus Forecasts Issued *prior to* Management Forecasts

	N	(-∞, Low)	[Low, Mid]	{Mid}	(Mid, High]	(High, +∞)	Asymmetry		% in range	Range Width		
		(a)	(b)	(c)	(d)	(e)	(a)/(e)	(a+b)/(d+e)	(b+c+d)	Mean	Median	Std. Dev
Fq1	2,765	23.9%	18.7%	2.6%	20.8%	34.0%	0.703	0.777	42.1%	0.141	0.100	0.115
Fq2	2,709	29.3%	23.5%	2.8%	21.0%	23.4%	1.252	1.189	47.3%	0.136	0.100	0.112
Fq3	2,803	28.8%	21.2%	3.3%	19.1%	27.6%	1.043	1.071	43.6%	0.117	0.100	0.101
Fq4	2,712	35.7%	16.0%	3.8%	14.3%	30.2%	1.182	1.162	34.1%	0.075	0.050	0.073
Total	**10,989**	**29.4%**	**19.9%**	**3.1%**	**18.8%**	**28.8%**	**1.021**	**1.036**	**41.8%**	**0.117**	**0.100**	**0.105**

Panel B: Revised Analyst Consensus Forecasts *post* Management Forecasts

	N	(-∞, Low)	[Low, Mid)	{Mid}	(Mid, High]	(High, +∞)	Asymmetry		% in range	Range Width		
		(a)	(b)	(c)	(d)	(e)	(a)/(e)	(a+b)/(d+e)	(b+c+d)	Mean	Median	Std. Dev
Fq1	2,765	14.4%	27.5%	7.0%	34.3%	16.8%	0.857	0.820	68.8%	0.141	0.100	0.115
Fq2	2,709	14.8%	24.1%	5.6%	32.6%	22.9%	0.646	0.701	62.3%	0.136	0.100	0.112
Fq3	2,803	12.3%	26.2%	6.5%	33.9%	21.1%	0.583	0.700	66.6%	0.117	0.100	0.101
Fq4	2,712	11.4%	24.0%	9.4%	34.2%	21.0%	0.543	0.641	67.6%	0.075	0.050	0.073
Total	**10,989**	**13.2%**	**25.5%**	**7.1%**	**33.8%**	**20.4%**	**0.647**	**0.714**	**66.4%**	**0.117**	**0.100**	**0.105**

This table presents the distribution of the median analyst forecasts that are issued prior to and after the management forecasts with reference to management forecast ranges, partitioned into five mutually exclusive cases (columns (a) through (e)): (-∞, Low), [Low, Mid), {Mid}, (Mid, High], and (High, +∞), where "Low," "Mid," and "High" indicates the lower bound, midpoint, and upper bound of management forecasts, respectively. The sample includes 10,989 management range forecasts of annual earnings of fiscal years between 1996 and 2011. Two measures of asymmetry are defined as ratios of the total number of observations to the left versus to the right of the range (or of the middle point). Fq1 (Fq2, Fq3, or Fq4) indicates that the management annual forecast is issued during the first (second, third, or fourth) fiscal quarter of the year.

TABLE 3: Descriptive Statistics

Panel A: Summary Statistics

Variables	N	Mean	Std Dev	25%	Median	75%
Revision (%)	10,989	-0.053	0.644	-0.177	0.039	0.193
AFE_PRE (%)	10,989	-0.274	1.877	-0.532	0.058	0.462
News_Mid (%)	10,989	-0.048	0.642	-0.193	0.000	0.179
Width (%)	10,989	0.406	0.411	0.154	0.279	0.490
Bundle_Eanews (%)	9,062	0.082	0.340	0.000	0.062	0.180
Fq1	10,989	0.252	0.434	0.000	0.000	1.000
Fq2	10,989	0.247	0.431	0.000	0.000	0.000
Fq3	10,989	0.255	0.436	0.000	0.000	1.000
Dispersion	10,599	0.003	0.004	0.001	0.002	0.003
RetVol	10,983	0.024	0.013	0.015	0.021	0.030
D_LastActualClosertoUpper	7,617	0.626	0.484	0.000	1.000	1.000
D_WiderThanLast	7,660	0.521	0.450	0.000	1.000	1.000
D_MeetAF	9,730	0.787	0.409	1.000	1.000	1.000
D_GuideDown	10,989	0.276	0.447	0.000	0.000	1.000

The sample includes 10,989 management range forecasts of annual earnings of fiscal years between 1996 and 2011.All continuous variables are winsorized at the 1^{st} and 99^{th} percentiles. Please see the Appendix for all variable definitions.

Panel B: Correlation Matrix

	Revision	***AFE_PRE***	***News_Mid***	***Width***	***Bundle_Eanews***	***Fq1***	***Fq2***	***Fq3***	***D_Dispersion***	***D_Ret-Vol***	***D_Last-Actual-Closer-toUpper***	***D_Wider-Than-Last***	***D_Meet-AF***	***D_Guide-Down***
Revision	**1.000**													
AFE_PRE	**0.517**	**1.000**												
News_Mid	**0.785**	**0.390**	**1.000**											
Width	**-0.201**	**-0.156**	**-0.114**	**1.000**										
Bundle_Eanews	**0.421**	**0.318**	**0.308**	**0.038**	**1.000**									
Fq1	**-0.090**	**-0.075**	**-0.075**	**0.115**	**-0.025**	**1.000**								
Fq2	**0.034**	-0.022	**0.042**	**0.096**	0.012	**-0.332**	**1.000**							
Fq3	0.020	0.019	0.012	-0.018	0.005	**-0.339**	**-0.335**	**1.000**						
D_Dispersion	**-0.089**	**-0.097**	**-0.045**	**0.417**	0.011	**0.145**	**0.029**	**-0.033**	**1.000**					
D_RetVol	**-0.088**	**-0.091**	**-0.032**	**0.229**	0.022	-0.006	**-0.033**	-0.008	**0.222**	**1.000**				
D_LastActual-ClosertoUpper	**0.128**	**0.124**	**0.061**	**-0.222**	**0.062**	**-0.091**	-0.021	0.009	**-0.146**	**-0.109**	**1.000**			
D_WiderThan-Last	**-0.125**	**-0.118**	**-0.047**	**0.276**	-0.017	0.000	-0.005	0.013	**0.124**	**0.170**	**-0.151**	**1.000**		
D_MeetAF	**0.109**	**0.115**	**0.071**	**-0.119**	**0.157**	-0.019	0.000	0.013	**-0.074**	-0.005	**0.251**	**-0.071**	**1.000**	
D_GuideDown	**-0.489**	**-0.238**	**-0.603**	0.001	**-0.198**	**0.064**	**-0.067**	-0.013	**0.073**	**0.037**	**-0.049**	0.022	**-0.062**	**1.000**

This table presents the Pearson pairwise correlation coefficients. Correlations in bold are significantly different from zero at the 1% level. All continuous variables are winsorized at the 1st and 99th percentiles. Please see the Appendix for all variable definitions.

TABLE 4: Analysts' Weights on the Upper and Lower Bounds of Management Range Forecasts

$$Revision_{i,t} = a + b(News\_Mid_{i,t}) + b(\theta - 0.5) * Width_{i,t} + \varepsilon$$

	Base Model	Model (1M)	Base Model	Model (1M)
	(1)	(2)	(3)	(4)
Intercept	-0.0002***	0.001***	-0.001	-0.001
	(-3.25)	(8.00)	(-0.79)	(-0.46)
News_Mid	0.788***	0.775***	0.785***	0.771***
	(55.05)	(55.06)	(54.58)	(54.38)
Width		-0.177***		-0.198***
		(-8.56)		(-9.09)
θ-0.5		-0.229***		-0.256***
(t- stat)		(-8.24)		(-8.71)
Implied θ		0.271***		0.244***
(t- stat)		(9.75)		(8.29)
Industry Fixed Effect	No	No	Yes	Yes
Year Fixed Effect	No	No	Yes	Yes
No of OBS	10,989	10,989	10,989	10,989
Adjusted R-Squared	61.6%	62.9%	62.5%	63.8%

This table presents results from OLS regressions of analyst forecast revisions on management forecast news and range widths. The sample includes 10,989 management range forecasts of annual earnings of fiscal years between 1996 and 2011. Please see the Appendix for all variable definitions. *T*-stats are based on standard errors clustered on the firm level. *, **, and *** indicate significance level lower than 10%, 5%, and 1%, respectively. θ is the hypothetical weight that analysts place on the upper bound of management forecast ranges when revising their own forecasts. T-stats about θ are calculated using the delta method (Rao 1956).

TABLE 5: Accounting for Earnings News Bundled with Management Range Forecasts

$Revision_{i,t} = a + b(News\_Mid_{i,t}) + b(\theta - 0.5) * Width_{i,t} + c\ Bundle\_Earnews + \varepsilon$

	All Management Forecasts	Stand-alone Management Forecasts	Bundled Management Forecasts	Bundled Management Forecasts with Positive Earnings News	Bundled Management Forecasts with Negative Earnings News	Bundled Management Forecasts[a]
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-0.001	0.003**	-0.001	-0.001	-0.001	0.003***
	(-0.57)	(2.11)	(-0.73)	(-0.61)	(-0.52)	(7.94)
News_Mid	0.709***	0.710***	0.704***	0.703***	0.698***	0.549***
	(45.83)	(17.30)	(40.04)	(32.53)	(24.26)	(6.95)
Width	-0.215***	-0.312***	-0.199***	-0.175***	-0.242***	-0.155***
	(-10.35)	(-5.53)	(-9.42)	(-8.02)	(-6.08)	(-3.03)
Bundle_Eanews	0.422***		0.422***	0.399***	0.321***	
	(15.81)		(14.67)	(10.82)	(5.58)	
θ-0.5	-0.303***	-0.440***	-0.283***	-0.249***	-0.346***	-0.282***
(t- stat)	(-9.72)	(-4.91)	(-8.90)	(-7.85)	(-5.57)	(-3.15)
Implied θ	0.197***	0.060	0.217***	0.251***	0.154**	0.218**
(t- stat)	(6.30)	(0.67)	(6.81)	(7.88)	(2.47)	(2.43)
Industry Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
No of OBS	10,989	1,927	9,062	6,966	2,096	4,874
Adjusted R-Squared	67.4%	57.7%	69.7%	65.5%	66.9%	55.9%

This table presents results from OLS regressions of analyst forecast revisions on management forecast news and range widths, controlling bundled earnings announcement news. The sample includes 10,989 management range forecasts of annual earnings of fiscal years between 1996 and 2011, of which 9,062 management forecasts are bundled with quarterly earnings announcements. Please see the Appendix for all variable definitions. *T*-stats are based on standard errors clustered on the firm level. *, **, and *** indicate significance level lower than 10%, 5%, and 1%, respectively. θ is the hypothetical weight that analysts place on the upper bound of management forecast ranges when revising their own forecasts. T-stats about θ are calculated using the delta method (Rao 1956). a: This column uses conditional expectations to calculate analyst forecast revisions and management forecast news, following the method described in Rogers and Van Buskirk (2013).

TABLE 6: Cross-Sectional Analysis of Analysts' Weights on Range Forecast Bounds

$Revision_{i,t} = \beta_0 + \beta_1(News\_Mid_{i,t}) + \beta_2 Width_{i,t} + \beta_3(Width_{i,t} * X_{i,t}) + \beta_4 X_{i,t} + \beta_5 Bundle\_Eanews_{i,t} + \varepsilon$				
X As		*D_WideRange*	*D_Dispersion*	*D_RetVol*
	(1)	(2)	(3)	(4)
Intercept	-0.001	-0.001	-0.001	-0.001
	(-0.78)	(-0.74)	(-0.77)	(-0.90)
News_Mid	0.706***	0.709***	0.716***	0.708***
	(45.43)	(45.83)	(47.34)	(46.11)
Width	-0.147***	-0.115**	-0.098***	-0.066*
	(-4.19)	(-2.32)	(-3.41)	(-1.85)
Width Fq1*	-0.144***			
	(-3.03)			
Width Fq2*	-0.062			
	(-1.26)			
Width Fq3*	-0.018			
	(-0.36)			
Width X*		-0.110**	-0.139***	-0.182***
		(-2.02)	(-3.99)	(-4.53)
Fq1	0.001***			
	(2.90)			
Fq2	0.0004**			
	(2.43)			
Fq3	0.0002			
	(1.07)			
X		0.0003*	0.0003**	0.0003**
		(1.71)	(2.29)	(2.23)
Bundle_Eanews	0.420***	0.421***	0.412***	0.420***
	(15.80)	(15.77)	(14.97)	(15.74)
Implied θ When X=0	0.292***	0.338***	0.363***	0.407***
(t- stat)	(5.78)	(4.84)	(8.98)	(8.05)
θ – 0.5 When X=0	-0.208***	-0.162**	-0.137***	-0.093*
(t- stat)	(-4.13)	(-2.31)	(-3.37)	(-1.84)
Difference in Implied θ	-0.204***[a]	-0.155**	-0.195***	-0.258***
(t- stat)	(-3.00)	(-2.02)	(-3.96)	(-4.50)
Industry Fixed Effect	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
No of OBS	10,989	10,989	10,599	10,983
Adjusted R-Squared	67.6%	67.4%	68.3%	67.7%

This table reports results from OLS regressions to examine the cross-sectional variations in the weight analysts place on the upper and lower bounds of management range forecasts. The sample includes 10,989 management range forecasts of annual earnings of fiscal years between 1996 and 2011. The actual sample size varies due to the unavailability of independent variables. The dependent variable is *Revision*. Please see the Appendix for all variables definitions. *T*-stats are based on standard errors clustered on the firm level. *, **, and *** indicate significance level lower than 10%, 5%, and 1%, respectively. θ is the hypothetical weight that analysts place on the upper bound of management forecast ranges when revising their own forecasts. T-stats about θ are calculated using the delta method (Rao 1956). a: The difference in implied θ in this case is between *Fq1* and *Fq4*.

Table 7: Additional Cross-Sectional Analysis of Analysts' Weight on Forecast Bounds

$Revision_{i,t} = \beta_0 + \beta_1(News\_Mid_{i,t}) + \beta_2 Width_{i,t} + \beta_3(Width_{i,t} {*} X_{i,t}) + \beta_4 X_{i,t} + \beta_5 Bundle\_Eanews_{i,t} + \varepsilon$

	Are Analysts "Bayesian"?		**Is "Lowballing" the Explanation?**	
X As	*D_LastActualCloser-toUpper*	*D_WiderThan Last*	*D_MeetAF*	*D_GuideDown*
	(1)	(2)	(3)	(4)
Intercept	-0.001**	-0.003***	-0.001	-0.001
	(-2.54)	(-5.23)	(-0.81)	(-0.50)
News_Mid	0.724***	0.726***	0.709***	0.682***
	(36.51)	(38.13)	(43.85)	(33.66)
Width	-0.239***	0.062*	-0.215***	-0.209***
	(-7.60)	(1.79)	(-4.88)	(-9.16)
Width X*	0.082*	-0.323***	0.006	-0.037
	(1.73)	(-7.95)	(0.13)	(-0.85)
X	0.0001	0.001***	0.0001	-0.0004***
	(0.53)	(4.06)	(0.71)	(-2.68)
Bundle_Eanews	0.387***	0.387	0.418***	0.422***
	(12.29)	(12.26)	(14.55)	(15.86)
Implied θ When X=0	0.170***	0.586***	0.197***	0.193***
(t- stat)	(3.75)	(12.21)	(3.09)	(5.57)
θ – 0.5 When X=0	-0.330	0.086*	-0.303***	-0.307***
(t- stat)	(-7.31)	(1.79)	(-4.76)	(-8.84)
Difference in Implied θ	0.113*	-0.445***	0.009	-0.054
(t- stat)	(1.73)	(-7.64)	(0.13)	(-0.85)
Industry Fixed Effect	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
No of OBS	7,617	7,660	9,730	10,989
Adjusted R-Squared	68.0%	68.7%	67.8%	67.5%

This table reports results from OLS regressions to examine: (a) whether analysts are "Bayesian" and learn from their past experience, and (b) whether analysts' overweight on the lower bound of management range forecast can be explained by their incentives of "lowballing." The sample is based on 10,989 management range forecasts of annual earnings between 1996 and 2011. The actual sample size varies due to the unavailability of independent variables. The dependent variable is *Revision*. Please see the Appendix for all variable definitions. *T*-stats are based on standard errors clustered on the firm level. *, **, and *** indicate significance level lower than 10%, 5%, and 1%, respectively. θ is the hypothetical weight that analysts place on the upper bound of management forecast ranges when revising forecasts. T-stats about θ are calculated using the delta method (Rao 1956).

TABLE 8: Optimal Weights on Management Range Forecast Bounds

$AFE\_PRE_{i,t} = a + b(News\_Mid_{i,t}) + b(\theta - 0.5) * Width_{i,t} + c\ Bundle\_Eanews_{i,t} + \varepsilon$

	All Management Forecasts	All Management Forecasts	Bundled Management Forecasts	Bundled Management Forecasts	Bundled Management Forecasts with Positive Earnings News	Bundled Management Forecasts with Negative Earnings News
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-0.001**	-0.0004	-0.001***	-0.002	-0.0002	-0.009
	(-2.56)	(-0.08)	(-2.70)	(-0.44)	(-0.05)	(-0.67)
News_Mid	0.889***	0.867***	0.826***	0.819***	0.890***	0.711***
	(15.75)	(16.07)	(13.64)	(14.24)	(12.49)	(7.37)
Width	-0.592***	-0.722***	-0.573***	-0.680***	-0.502***	-0.917***
	(-5.89)	(-7.29)	(-5.58)	(-6.56)	(-4.17)	(-6.07)
Bundle_Eanews	1.391***	1.250***	1.426***	1.293***	1.065***	1.337***
	(13.45)	(12.48)	(13.40)	(12.46)	(7.13)	(6.01)
θ-0.5	-0.666***	-0.832***	-0.694***	-0.830***	-0.564***	-1.290***
(t- stat)	(-5.31)	(-6.27)	(-5.02)	(-5.76)	(-3.82)	(-4.72)
Implied θ	-0.166	-0.332**	-0.194	-0.330**	-0.064	-0.790***
(t- stat)	(-1.32)	(-2.50)	(-1.40)	(-2.29)	(-0.43)	(-2.89)
Industry Fixed Effect	No	Yes	No	Yes	Yes	Yes
Year Fixed Effect	No	Yes	No	Yes	Yes	Yes
No of OBS	10,989	10,989	9,062	9,062	6,966	2,096
Adjusted R-Squared	21.2%	26.3%	21.7%	26.8%	20.3%	27.6%

This table reports results from OLS regressions to examine the optimal weights on the upper and lower bounds of management range forecasts, assuming that analysts possess perfect foresight of actual earnings. The full sample includes 10,989 management range forecasts of annual earnings of fiscal years between 1996 and 2011. The actual sample size varies due to the unavailability of independent variables. The dependent variable is *AFE_PRE*, which reflects the optimal revision assuming perfect foresight of actual earnings. Please see the Appendix for all variable definitions. *T*-stats are based on standard errors clustered on the firm level. *, **, and *** indicate significance level lower than 10%, 5%, and 1%, respectively. θ is the hypothetical weight that the optimal analyst forecast revisions should place on the upper bound of management forecast ranges. T-stats about θ are calculated using the delta method (Rao 1956).