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How does the market process sequential earnings information?☆

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ABSTRACT

Employing both experimental market and archival research designs, we examine whether the association between announcement period stock returns and contemporaneous news is influenced by previously disclosed earnings news. Our primary conclusion is that investors' response to the earnings surprise (actual earnings less the last forecast of the quarter) is conditional on the sign of prior earnings news (i.e., the forecast revision). We develop and test predictions based on behavioral theories of how investors will react to a series of earnings information. Our results suggest that the market's response to sequential analysts' forecasts is consistent with the application of an end-of-sequence (EoS) process resulting in a primacy effect.

1. Introduction

Hogarth and Einhorn (1992) suggest in their Belief Adjustment (BA) model that when individuals are presented with sequential bits of information, their decisions are predictably influenced by how they cognitively process the information, step-by-step (SbS) or end-of-sequence (EoS). The SbS process suggests that investors will primarily be influenced by the last piece of news while the EoS process suggests that investors will be influenced not only by the last piece of news but also by earlier pieces of news. Based on the theory underlying the BA model, we posit that the cognitive processing effects observed in individual decision-making[3] potentially contribute to the market premium (penalty) for beating (missing) analysts' earnings forecasts.[4] Specifically, we investigate whether market behavior which leads to a stock price premium (penalty) for beating (missing) analysts' earnings forecasts is consistent with investors processing sequential earnings forecasts in a step-by-step (SbS) or end-of-sequence (EoS) manner resulting in a recency or primacy effect.

Prior experimental research (Libby & Tan, 1999; Miller, 2006; Tan, Libby, & Hutton, 2002) suggests that analyst forecasts of future earnings are influenced by how quarterly earnings information is communicated to the market. That is, holding quarterly total earnings news constant (i.e., actual quarterly earnings less the first forecast of the quarter), analysts respond differently to the earnings news based on the order in which they receive the various pieces of earnings news. For example, preannounced earnings news of $1.00 and a negative earnings surprise of $(0.50) result in a significantly different analyst forecast of future earnings than preannounced earnings news of $(0.50) and a positive earnings surprise of $1.00 even though both earnings expectation paths have the same $0.50 of total quarterly earnings news. Taken together, prior research provides compelling evidence of a significant order effect associated with sequentially disclosed earnings news consistent with the predictions of the BA model.

In contrast to the prior literature, our investigation does not address the order effect aspect of the BA model. Rather, our focus is on how market participants process sequential earnings news (i.e., SbS or EoS). Specifically, we focus solely on the response of investors to the last piece of earnings news (i.e., earnings surprise) and whether cognitive processing affects the pricing of the earnings surprise holding the magnitude of the surprise constant. Fig. 1 visually demonstrates the distinction between our focus on the processing strategy applied and the impact of order. Prior research which investigates the order implications of the BA model contemplates the market response to total quarterly earnings news (quarterly return) conditioned on the sign of the revision and earnings surprise. On the other hand, our study investigates the processing

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[3] Cognitive processing effects have proven robust in a variety of settings (i.e., juror decisions (Furnham, 1986); auditing (Asare & Messier, 1991); tax reporting and evaluation (Cuccia & McGill, 2000; Pei, Reckers, & Wyndelts, 1992); social judgments and attributions for behavior (Lichenstein & Scrull, 1987; Luchins & Luchins, 1984); and judgments of probability (Shanteau, 1970, 1972)).

[4] Prior research finds that the market provides a stock price premium (penalty) to firms based solely on the sign of the earnings surprise even after controlling for the magnitude of the surprise (e.g., Brown & Caylor, 2005; Kasznik & McNichols, 2002; Lopez & Rees, 2002).

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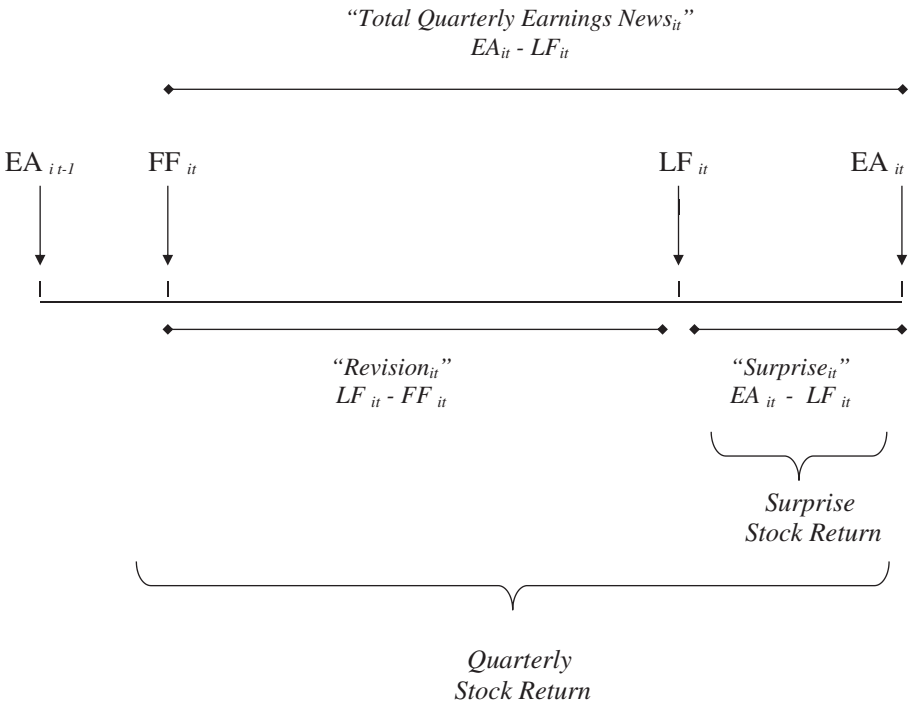

$EA_{i,t-1}$	Firm *i's* quarter *t-1* earnings is announced.
FF_{it}	Analysts' First Forecast of Firm *i's* earnings for quarter *t*
LF_{it}	Analysts' Last Forecast of Firm *i's* earnings for quarter *t* prior to earnings announcement
EA_{it}	Firm *i's* quarter *t* earnings is announced
$Revision_{it}$	Analysts' Last Forecast minus First Forecast of Firm *i's* earnings for quarter *t* (LF_{it} - FF_{it})
$Surprise_{it}$	Firm *i's* actual earnings for quarter *t* less analysts' last forecast of quarter *t* (EA_{it} - LF_{it})
Stock Return	market return in the short window around the announcement of earnings for quarter *t*.

Fig. 1. Quarterly earnings disclosure timeline.

strategy implications of the BA model by focusing on the response of the market to the earnings surprise (surprise stock return) conditioned on the sign of prior earnings news (i.e., the revision).

The sequential process of analysts issuing and subsequently revising earnings forecasts, followed by managers reporting of actual earnings at the end of the quarter appears consistent with a SbS "response mode" described by Hogarth and Einhorn's (1992) BA model. However, Hogarth and Einhorn (1992, 12) note that how individuals process information (i.e., processing strategy) is not always the same as how the information is released or presented. For example, Hogarth and Einhorn suggest that the EoS response mode (i.e., asking participants for one judgment after receiving all data) does not mean that the subjects are not applying a SbS process (i.e., updating their beliefs as they receive each piece of new information). Importantly, Hogarth and Einhorn (1992, 12–14) indicate that the manner in which a response (i.e., response mode) is sought from the subjects (SbS or EoS) does not necessarily coincide with the "processing" of the information (SbS or EoS).[5]

Hogarth and Einhorn (1992, 12) also note that when a "task demands" a SbS response mode, one cannot use an EoS process and that an "EoS response mode can be met by using either an EoS or SbS process" by participants. While they do not specifically address the scenario where no particular response mode is demanded of participants, it is clear from their discussion that a setting of sequential pieces of information that makes no response demand of participants, such as analyst forecasts and earnings announcements, can be met by either a SbS or an EoS process.

It would be convenient to assume that market participants always use a SbS process because the earnings information is released in a sequential manner; however, prior research provides compelling reasons to believe that may not actually be the case (e.g., Hogarth & Einhorn, 1992; Nisbett, Ross, & L., 1980). Thus, the step-by-step nature of analysts issuing and subsequently revising earnings forecasts, followed by managers reporting of actual earnings at the end of the quarter does not necessarily imply that market participants will fully update their beliefs (SbS process) as the information is released since no market response is required with each release of data. Consequently, a potential unexplored possibility is that the observed market premium (penalty) for beating (missing) analysts forecasts (i.e., the earnings surprise) is, at least in part, a manifestation of the cognitive processing of sequential pieces of information by market participants at the end of the sequence (i.e., the earnings announcement date).

Prior research which examines the market premium (penalty) associated with beating (missing) analysts' earnings forecasts focuses on aggregate market behavior using capital market research designs. While this type of research design is informative in examining overall market behavior it is limited in its ability to control for confounding effects and to ascertain individual investor behavior. Accordingly, in this study we first employ an experimental market to examine whether

[5] Similar to Hogarth and Einhorn, we use the same terminology (acronyms) to describe a response mode and a processing strategy. However, in the text we are careful to distinguish between the two by indicating when we are referring to a "response mode" versus a "processing strategy."

the cognitive processing of earnings contributes to the observed market premium (penalty) for firms that beat (miss) analysts' expectations. We then expand our empirical analyses to include an archival examination of the same question to determine if our experimental results also manifest in aggregate market behavior.

In our experimental market, we provide participants with five analysts' forecasts of the expected liquidating dividend. The forecasts are issued sequentially and participants are provided with adequate time to trade after the issuance of each forecast. We run six different patterns of forecasts, three of which end up with a positive surprise and three of which end up with a negative surprise. The pattern of forecasts for the positive and negative surprise paths prior to the last forecast is either good news (the fourth forecast is greater than the first forecast), zero news (the fourth forecast is equal to the first forecast), or bad news (the fourth forecast is less than the first forecast). After trading concludes at the end of the fifth period (after the fifth forecast), the holder of the security is paid a liquidating dividend that is unspecified in the experimental instrument. The only information the participants are provided concerning the liquidating dividend is that forecasts "generally" become more accurate the closer to the actual dividend announcement.

Our experimental results suggest that the market's response to sequential analysts' forecasts is consistent with the application of an end-of-sequence (EoS) process resulting in a primacy effect. Consistent with this conclusion, we find that a positive surprise (the fifth forecast exceeds the fourth forecast) that is preceded by good news (the fourth forecast exceeds the first forecast) is valued more than a positive surprise that is preceded by bad news. We find that the premium for reporting a positive surprise, after controlling for the magnitude of the dividend surprise, is 4.3% more if the firm also had good news before the last forecast than if the firm had bad news before the last forecast. Similarly, we find that the penalty for reporting a negative surprise, after controlling for the magnitude of the dividend surprise, is 4.6% more negative if the firm also had bad news than if the firm had good news prior to the last forecast. Overall, our evidence suggests that market participants significantly rely on earlier forecasts in evaluating the valuation implications of the last dividend forecast, a result consistent with end-of-sequence processing (EoS).

Similarly, our archival results suggest that the market's response, on average, to earnings surprises is consistent with the application of an EoS process resulting in a primacy effect.[6] Consistent with this conclusion, we find that the premium resulting from a positive earnings surprise is contingent on the sign of the forecast revision (i.e., the last earnings forecast of the quarter less the first earnings forecast of the quarter). Specifically, the premium for reporting a positive earnings surprise, after controlling for the magnitude of the surprise, is 62% greater if the firm also had a positive forecast revision during the quarter. Similarly, the penalty for reporting a negative earnings surprise, after controlling for the magnitude of the earnings surprise, is 62% more negative if the firm also had a negative forecast revision during the quarter.

In this paper, we explore whether the cognitive processing effects observed in individual decision-making correspond with market behavior. Despite the fact that market participants regularly receive streams of information that they use to revise their valuation estimates, limited empirical evidence exists that examines cognitive processing effects in a capital market context (Koonce & Mercer, 2005; Lee, 2001). Our study bridges that gap. Importantly, our experimental and archival results reveal a remarkably consistent story. In particular, our results suggest that the cognitive processes observed in experimental settings are also manifested in aggregate market behavior. Taken together, we believe that our study incorporates theories of both the experimental and archival literatures to offer a more complete explanation for how market participants process sequential earnings news. The results of our study also have important implications for managers and analysts. Prior research suggests that managers often guide analysts' forecasts downward in order to meet or beat expectations (Matsumoto, 2002). Our results suggest that both managers and analysts might want to reconsider the process of analyst forecast guidance.

The remainder of the paper is organized as follows: Section 2 discusses the work of Hogarth and Einhorn (1992) and prior analyst forecast revision research in developing our research hypotheses. Section 3 presents the research design while Section 4 discusses the sample selection and provides descriptive statistics. Section 5 discusses the empirical results while Section 6 offers a brief summary and conclusion.

2. Background and hypothesis development

2.1. Hogarth and Einhorn's belief revision model

Hogarth and Einhorn (1992) develop a model of belief revision in which predictions are based on the classification of tasks along three dimensions: the task complexity, the length of the information series, and the processing strategy. Task complexity categorizes information as simple or complex. The complexity of the information depends on the amount of the information and on how familiar the participants are with the information presented. Simple tasks are those where the participant is familiar with the meaning of the information; whereas, complex tasks are those where the participant is unfamiliar with the meaning of the information (Hogarth & Einhorn, 1992, 5). In the context of our study, market participants are assumed to be familiar with the meaning of analysts' earnings estimates. The length of the information series is based on how many pieces of information are presented to participants. Hogarth and Einhorn (1992, 6) label the length of information as a short series when it consists of 2 to 12 pieces of information and a long series when it consists of 17 or more pieces of information. In our experimental market we hold the length of the forecast sequence constant at five forecasts (i.e., a short sequence). In the context of our archival analysis, the length of the information series can be either short or long. However, the mean number of analyst forecasts per period for our sample is 6.4 and only 10% of our sample observations would be described as a long information series (greater than 16 individual forecasts per quarter).

The processing strategy consists of two types, the step-by-step (SbS) and the end-of-sequence (EoS), and denotes how an individual processes the series of information received (Hogarth & Einhorn, 1992, 12). In a SbS process, the implications of new evidence are encoded as a deviation relative to the previous item of evidence received, and more recently received evidence is given greater weight (a recency effect). In the context of the valuation of an earnings surprise, a SbS process suggests that positive (negative) surprises are equally rewarded (penalized) regardless of what information precedes the surprise. On the other hand, in an EoS process the new evidence received is evaluated in the context of all previously received evidence. In this EoS process there is an anchor (primacy) and adjustment. In the context of the valuation of an earnings surprise, an EoS process suggests that the reward (penalty) associated with a positive (negative) earnings surprise will be contingent on the information that preceded the earnings surprise.

Hogarth and Einhorn (1992) review the prior literature on recency and primacy effects and find several aspects of prior experiments that have a direct relation to this study. They report that of the 16 prior studies reviewed with a SbS response mode the conclusion was a recency effect whereas of the 27 studies reviewed with an EoS response mode, the conclusion was a primacy effect in 19 of the 27 studies. Moreover, Hogarth and Einhorn (1992) claim that the EoS studies resulting in recency effects involved experimental manipulations that probably affected the judgment process. They further summarize the literature and arrive at the following three conclusions. First, the response mode makes a difference in the case of short simple tasks. EoS induces primacy effects and SbS induces recency effects. Second, primacy effects seem to be obtained when

[6] Where the "earnings surprise" is defined as actual quarterly earnings less the last individual analysts' earnings forecast prior to the earnings announcement date for the quarter.

tasks are simple but long (independent of response mode). Third, recency effects are associated with more complex tasks (independent of response mode).

Overall, the experimental evidence provided by Hogarth and Einhorn (1992) with their review of prior behavioral studies suggests that primacy effects, which place significant reliance on the first piece of information, are observed when the length of the data is short or long, the response mode is an EoS, and the information is considered simple meaning that the participants are familiar with the information. Primacy effects are also observed when participants are presented with relatively long series of simple information and use the EoS response mode to process that information. However, when complex information is presented in a relatively short or long series with a SbS response mode a recency affect is observed, which suggests that greater reliance is given to the most recent piece of information when forming a decision. In general, when the task is simple, the primary determinant of whether a recency or primacy effect is observed is the response mode, SbS or EoS.

2.2. Analyst forecast revision literature

Two stylized facts emerge from prior research on investors' response to analyst forecast revisions. First, a significantly positive association between analysts' forecast revisions and stock price is observed. Prior research is replete with evidence that analysts' forecast revisions are value relevant (Givoly & Lakonishok, 1979, 1980; Imhoff & Lobo, 1984; Stickel, 1991). Second, the price response to analyst forecast revisions is incomplete. Givoly and Lakonishok (1980) report a post-revision drift in stock price after an analysts' earnings forecast revision. Similarly, Stickel (1991) reports that firms whose forecasts have been revised upward tend to earn higher abnormal returns over the next three to 12 months than firms whose forecasts have been revised downward.

Despite the fact that these empirical results are well-documented, relatively little is known about why this anomaly occurs. A potential explanation for the delayed market response to analyst forecast revisions is that the market applies an end-of-sequence process to evaluating earnings news. That is, investors, on average, delay incorporating all of the news in analysts' forecasts until all of the earnings news for the quarter, including actual earnings, are available. Our empirical tests are designed to test this proposition as a potential explanation for the market premium (penalty) associated with beating (missing) analysts' earnings forecasts.

2.3. Hypothesis development

The work of Hogarth and Einhorn (1992) suggests that recency or primacy effects may hold with respect to investors' response to earnings surprises depending on the processing strategy applied by market participants (SbS or EoS). In other words, since the task is familiar to market participants, it can lead to a recency or primacy effect depending on the processing strategy. The length of the information series (number of forecasts per firm per period), on average, is short, but it can also be long in some instances (over 10% of the quarterly observations have what Hogarth and Einhorn classify as a long series). Prior empirical research provides no clear pattern of recency or primacy effects based solely the length of the information series. The only factor that leads to a clear prediction of recency or primacy is the method by which market participants process earnings news (SbS or EoS); however, that is the only factor that we are unable to observe. Thus, to form a predictable hypothesis we need evidence suggestive of the cognitive processing method applied by the market.

Prior research on investors' response to analyst forecast revisions, discussed previously, seems to offer some guidance of the response mode investors' apply (on average). Stickel (1991) reports that, although stock prices are positively associated with analyst forecast revisions, stock prices do not immediately assimilate all information in analyst forecast revisions. The positive association between analyst forecast revisions and stock returns seems to suggest that investors generally apply a SbS process. However, the delayed market response to analyst forecast revisions suggests that a significant portion of investors may apply an EoS process.

In the context of this study, a SbS process suggests that investors will place lower weight on the first piece of evidence (the first forecast) than on the last piece of evidence, the actual earnings surprise. On the other hand, an EoS process suggests that investors will evaluate the last piece of evidence, the earnings surprise, in the context of the first piece of evidence, the first forecast (the anchor). These predictions rely on the Hogarth and Einhorn model and only require that we assume that the first forecast of the period and the last forecast of the period serve as reference points, and that the method by which market participants process earnings news (SbS or EoS) results in either a recency or primacy effect. Based on the work of Hogarth and Einhorn (1992) and the prior literature on the delayed market response to analyst forecast revisions we propose the following testable hypotheses:

H1. The stock return premium observed for firms that beat the last analysts' forecast of the quarter (positive surprise) is greater for firms that also have a positive forecast revision (the last forecast of the quarter is greater than the first forecast of the quarter) than for firms that have a negative forecast revision (the last forecast of the quarter is less than first forecast of the quarter).

H2. The stock return penalty observed for firms that miss the last analysts' forecast of the quarter (negative surprise) is more negative for firms that also have a negative forecast revision (the last forecast of the quarter is less than the first forecast of the quarter) than for firms that have a positive forecast revision (the last forecast of the quarter is greater than first forecast of the quarter).

In essence, our hypotheses (stated in the alternative form) predict a significant primacy effect based on our expectation that a significant portion of investors apply an EoS process in evaluating earnings-related news.

3. Experimental market research design and results

3.1. Description of the experiment

In our experiment, we provide participants with five sequential analysts' forecasts of the expected liquidating dividend of a firm and allow them to make buying and selling decisions through the use of a computerized double auction asset market. The patterns of the analyst forecasts were generated prior to conducting the experiment, and vary in sign and magnitude. All participants are endowed with equal shares and experimental dollars with which to trade during the double auction market.

During trading, analyst forecasts are issued sequentially, one at a time, and participants are provided with adequate time to trade after the issuance of each forecast. The predetermined analyst forecasts follow six distinct patterns and end by demonstrating either a negative or positive surprise. Three of the six patterns end in a positive surprise (the fifth forecast exceeds the fourth forecast), and the remaining three patterns end in a negative surprise (the fifth forecast is less than the fourth forecast). The only information the participants are provided concerning the value of the liquidating dividend is that forecasts "generally" become more accurate the closer to the actual dividend announcement. After the five analysts' forecasts have been announced to all participants, trading is closed and the value of dividend is announced. The analyst forecast patterns are presented graphically in Fig. 2.

3.2. Organization of the experiment

Subjects are recruited from two major universities through the use of in-class announcements and email. Each experimental session requires

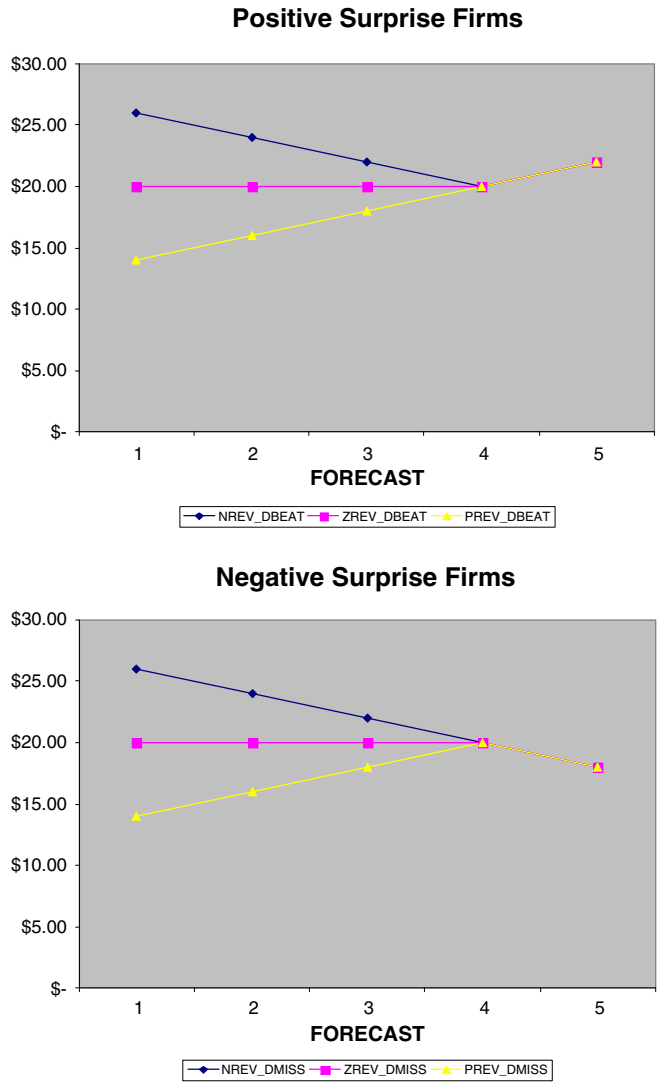

Fig. 2. Quarterly earnings expectation paths.

the participation of nine subjects recruited to be traders in an experimental market. Individual sessions last approximately 1 h and 30 min, including instruction period and a practice round, in which participants are allowed to ask questions regarding the interface for the software. The experiment was programmed and conducted with the software z-Tree (Fischbacher, 2007).

Each experimental session consists of a series of eight independent trading markets, all of which followed the same structure and format (see Appendix A). Each independent trading market is called a trading session, in which subjects are informed that they are trading with shares for one of the eight companies, labeled Company A through Company H. Only the direction of the analyst forecasts and value of the liquidating dividend vary between the companies. Subjects are endowed with five shares of a fictional asset and $150 experimental dollars (E$) with which they may use to trade at the beginning of each trading session. Subjects are required to pay back E$100 at the end of each trading session. Sufficient $E is provided to ensure that no subject would become bankrupt during the market and engage in risky selling or buying behavior.

3.3. Pre-sequence of analyst forecasts and dividends

We examine the six different patterns of forecasts in the experimental sessions. The pattern of forecasts for the positive and negative surprise paths prior to the last forecast is either a positive revision (the fourth forecast is greater than the first forecast), zero revision (the fourth forecast is equal to the first forecast) or negative revision (the fourth forecast is less than the first forecast).

In order to ensure that subjects are not able to anticipate the direction of the analyst forecasts or the dividend declared, we randomly pre-selected the paths that participants in each experimental session would receive. Further, we created four separate groups for the six different analyst forecast paths and final dividends that had different minimum and maximum forecasts and dividends. We made this design choice to minimize the likelihood of the subjects anticipating the path direction and final dividend payment. The four separate groups of the six distinct analyst forecast paths yield a total of twenty four unique paths. The actual paths including the forecasts and dividend are presented in Table 1. In order to mitigate order effects, all twenty four paths were randomly sorted. In each experimental session with eight trading markets, eight paths were selected from the total of twenty four and were traded between participants.

3.4. Research design

Prior research reports empirical evidence of a market premium (penalty) for beating (missing) analysts' earnings forecasts independent of the level of the earnings surprise (Bartov, Givoly, & Hayn, 2002; Brown & Caylor, 2005; Lopez & Rees, 2002). As a starting point for the analysis of the experimental data, we estimate a model based on the prior archival literature to see if the market premium (penalty)

Table 1
Experimental analyst forecast paths and dividends.

Forecast path	Forecast 1	Forecast 2	Forecast 3	Forecast 4	Forecast 5	Dividend
NREV_DBEAT	$ 26.00	$ 24.00	$ 22.00	$ 20.00	$ 22.00	$ 22.20
ZREV_DBEAT	20.00	20.00	20.00	20.00	22.00	23.00
PREV_DBEAT	14.00	16.00	18.00	20.00	22.00	24.00
NREV_DMISS	26.00	24.00	22.00	20.00	18.00	16.00
ZREV–_DMISS	20.00	20.00	20.00	20.00	18.00	17.00
PREV_DMISS	14.00	16.00	18.00	20.00	18.00	17.50
NREV_DBEAT	34.00	32.00	30.00	28.00	30.00	28.50
ZREV_DBEAT	28.00	28.00	28.00	28.00	30.00	31.00
PREV_DBEAT	22.00	24.00	26.00	28.00	30.00	32.00
NREV_DMISS	34.00	32.00	30.00	28.00	26.00	24.00
ZREV–_DMISS	28.00	28.00	28.00	28.00	26.00	25.50
PREV_DMISS	22.00	24.00	26.00	28.00	26.00	26.00
NREV_DBEAT	39.00	36.00	33.00	30.00	33.00	33.30
ZREV_DBEAT	30.00	30.00	30.00	30.00	33.00	34.50
PREV_DBEAT	21.00	24.00	27.00	30.00	33.00	36.00
NREV_DMISS	39.00	36.00	33.00	30.00	27.00	24.00
ZREV–_DMISS	30.00	30.00	30.00	30.00	27.00	25.50
PREV_DMISS	21.00	24.00	27.00	30.00	27.00	26.25
NREV_DBEAT	51.00	48.00	45.00	42.00	45.00	42.75
ZREV_DBEAT	42.00	42.00	42.00	42.00	45.00	46.50
PREV_DBEAT	33.00	36.00	39.00	42.00	45.00	48.00
NREV_DMISS	51.00	48.00	45.00	42.00	39.00	36.00
ZREV–_DMISS	42.00	42.00	42.00	42.00	39.00	38.25
PREV_DMISS	33.00	36.00	39.00	42.00	39.00	39.00

NREV_DBEAT the fourth forecast is less than the first forecast and the fifth forecast is greater than the fourth forecast,
ZREV_DBEAT the fourth forecast is equal to the first forecast and the fifth forecast is greater than the fourth forecast,
PREV_DBEAT the fourth forecast is greater than the first forecast and the fifth forecast is greater than the fourth forecast,
NREV_DMISS the fourth forecast is less than the first forecast and the fifth forecast is less than the fourth forecast,
ZREV_DBEAT the fourth forecast is equal to the first forecast and the fifth forecast is less than the fourth forecast,
PREV_DBEAT the fourth forecast is greater than the first forecast and the fifth forecast is less than the fourth forecast.

to beating or missing analysts' forecasts is present in our experimental data. Specifically, we estimate the following model:

$$R = \beta_1 DBEAT + \beta_3 DMISS + \beta_3 SURP \quad (1)$$

where:

R traded price after forecast number 5 less the fifth analyst forecast, scaled by the fourth (lagged) analyst forecast;
DBEAT indicator variable coded 1 if the difference between the fifth and fourth forecast is positive, otherwise 0;
DMISS indicator variable coded 1 if the difference between the fifth and fourth forecast is negative, otherwise 0;
SURP the surprise measured as the fifth forecast less the fourth forecast scaled by the fourth forecast.

The objective of our study is to empirically examine whether cognitive processing contributes to the premium (penalty) associated with beating (missing) analysts' forecasts. Specifically, we examine whether, after controlling for the sign and magnitude of the surprise, the stock price premium (penalty) associated with beating (missing) analysts' forecasts is consistent with investors processing earning news by looking back to earlier earnings news to price the most recent earnings news.

To test for the cognitive processing method applied by market participants, we modify Eq. (1) by partitioning DBEAT (DMISS) based on whether the forecast revision, REV (the difference between the first and fourth forecast), is positive, zero, or negative. These partitions allow us to test whether the market conditions its response to the SURP on the sign of the earnings news that preceded it (the sign of the forecast revision). We modify Eq. (1) as follows:

$$R = \gamma_1 PREV\_DBEAT + \gamma_2 ZREV\_DBEAT + \gamma_3 NREV\_DBEAT + \gamma_4 SURP \quad (2)$$

and

$$R = \gamma_1 PREV\_DMISS + \gamma_2 ZREV\_DMISS + \gamma_3 NREV\_DMISS + \gamma_4 SURP \quad (3)$$

where:

PREV_DBEAT indicator variable coded 1 if the difference between the fourth and first forecast is positive (PREV) and the difference between the fifth and fourth forecast is positive (DBEAT), otherwise 0;
ZREV_DBEAT indicator variable coded 1 if the difference between the fourth and first forecast is zero (ZREV) and the difference between the fifth and fourth forecast is positive (DBEAT), otherwise 0;
NREV_DBEAT indicator variable coded 1 if the difference between the fourth and first forecast is negative (NREV) and the difference between the fifth and fourth forecast is positive (DBEAT), otherwise 0;
PREV_DMISS indicator variable coded 1 if the difference between the fourth and first forecast is positive (PREV) and the difference between the fifth and fourth forecast is negative (DMISS), otherwise 0;
ZREV_DMISS indicator variable coded 1 if the difference between the fourth and first forecast is zero (ZREV) and the difference between the fifth and fourth forecast is negative (DMISS), otherwise 0; and
NREV_DMISS indicator variable coded 1 if the difference between the fourth and first forecast is negative (NREV) and the difference between the fifth and fourth forecast is negative (DMISS), otherwise 0.

All other variables are as previously defined.

3.5. Experimental market tests of H1 and H2

Eq. (1) results, not reported, are similar to those reported in the prior archival literature (Brown & Caylor, 2005; Lopez & Rees, 2002). Consistent with the prior archival literature, we find a significantly positive coefficient of 0.045 on DBEAT (two-tailed p-value < 0.01) and a significantly negative coefficient of −0.021 on DMISS (two-tailed p-value < 0.05). Thus, our experimental market data exhibits the same evidence of a market premium (penalty) for beating (missing) forecasts that is found in archival market data.

In Table 2 we report the results from the estimation of Eq. (2). The results indicate a significantly positive coefficient (two-tailed p-value < 0.05) on PREV_DBEAT and insignificant coefficients on ZREV_DBEAT and NREV_DBEAT. These results are interesting because prior research suggests that investors provide a premium (in the form of positive stock returns) for beating earnings expectations (independent of the magnitude of the earnings surprise). Our results confirm that conclusion only for firms that have a positive earnings surprise that is preceded by a positive forecast revision. SbS processing (recency) predicts no difference in the coefficients on PREV_DBEAT and NREV_DBEAT, while EoS processing (primacy) predicts that the coefficient on PREV_DBEAT will be significantly greater than the coefficient on NREV_DBEAT (i.e., $\gamma_1 > \gamma_3$). Consistent with H1, we find that the coefficient on PREV_DBEAT of 3.4% is significantly greater than the coefficient on NREV_DBEAT of 0.8% (two-tailed p-value < 0.01). Moreover, the coefficient on PREV_DBEAT of 3.4% is over 300% greater than the coefficient on NREV_DBEAT of 0.8%. Taken together the results in Table 2 suggest that the market applies EoS processing to earnings news resulting in a primacy effect that accounts for a significant portion of the stock return premium associated with beating analysts' forecasts.

In Table 3 we report the results from the estimation of Eq. (3). The results indicate significantly negative coefficients (two-tailed p-value < 0.05 or better) on PREV_DMISS, ZREV_DMISS and NREV_DMISS. These results are interesting because prior research suggests that investors attach a penalty (in the form of negative stock returns) for missing

Table 2
Empirical estimation of Eq. (2) and coefficient difference tests.
Panel A : Eq. (2) : $R = \gamma_1 PREV\_DBEAT + \gamma_2 ZREV\_DBEAT + \gamma_3 NREV\_DBEAT + \gamma_4 SURP (n = 535)$.

Variable	Prediction	Coefficient estimate [two tailed p-value]
PREV_DBEAT	>0	0.0335 [0.0105]
ZREV_DBEAT	?	0.0053 [0.6911]
NREV_DBEAT	?	0.0077 [0.5589]
SURP	>0	0.00594 [0.6826]
PREV_DBEAT–ZREV_DBEAT	>0	0.0281 [0.0001]
PREV_DBEAT–NREV_DBEAT	>0	0.0258 [0.0001]
ZREV_DBEAT–NREV_DBEAT	>0	−0.0023 [0.6395]

Variable definitions are as follows:

R traded price after forecast number 5 less the fifth analyst forecast, scaled by the fourth (lagged) analyst forecast;
PREV_DBEAT indicator variable coded 1 if the difference between the fourth and first forecast is positive (PREV) and the difference between the fifth and fourth forecast is positive (DBEAT), otherwise 0;
ZREV_DBEAT indicator variable coded 1 if the difference between the fourth and first forecast is zero (ZREV) and the difference between the fifth and fourth forecast is positive (DBEAT), otherwise 0;
NREV_DBEAT indicator variable coded 1 if the difference between the fourth and first forecast is negative (NREV) and the difference between the fifth and fourth forecast is positive (DBEAT), otherwise 0;
SURP the surprise measured as the fifth forecast less the fourth forecast scaled by the fourth forecast.

Table 3
Empirical estimation of Eq. (3) and coefficient difference tests.
Panel B : Eq. (3) : $R = \delta_1 PREV\_DMISS + \delta_2 ZREV\_DMISS + \delta_3 NREV\_DMISS + \delta_4 SURP (n = 447)$.

Variable	Prediction	Coefficient estimate [two tailed p-value]
PREV_DMISS	?	−0.0324 [0.0219]
ZREV_DMISS	?	−0.0431 [0.0031]
NREV_DMISS	<0	−0.0742 [0.0512]
SURP	>0	−0.6038 [0.0001]
NREV_DMISS–ZREV_ DMISS	>0	−0.0311 [0.0001]
NREV_DMISS–PREV_ DMISS	>0	−0.0418 [0.0001]
ZREV_DMISS–PREV_ DMISS	>0	−0.0107 [0.0458]

Variable definitions are as follows:

R traded price after forecast number 5 less the fifth analyst forecast, scaled by the fourth (lagged) analyst forecast;
PREV_DMISS indicator variable coded 1 if the difference between the fourth and first forecast is positive (PREV) and the difference between the fifth and fourth forecast is negative (DMISS), otherwise 0;
ZREV_DMISS indicator variable coded 1 if the difference between the fourth and first forecast is zero (ZREV) and the difference between the fifth and fourth forecast is negative (DMISS), otherwise 0;
NREV_DMISS indicator variable coded 1 if the difference between the fourth and first forecast is negative (NREV) and the difference between the fifth and fourth forecast is negative (DMISS), otherwise 0.
SURP the surprise measured as the fifth forecast less the fourth forecast scaled by the fourth forecast.

earnings expectations (independent of the magnitude of the earnings surprise). Unlike our results for positive surprise observations reported in Table 2, our results in Table 3 confirm that conclusion regardless of the sign of prior earnings news. SbS processing (recency) predicts no difference in the coefficients on PREV_DMISS and NREV_DMISS, while EoS processing (primacy) predicts that the coefficient on NREV_DMISS will be significantly more negative than the coefficient on PREV_DMISS (i.e., $\delta_1 > \delta_3$). Consistent with H2, we find that the coefficient on NREV_DMISS of −7.4% is significantly less than the coefficient on PREV_DMISS of −3.2% (two-tailed p-value < 0.01). Moreover, the coefficient on NREV_DMISS of −7.4% is 130% more negative than the coefficient on NREV_DBEAT of −3.2%. Taken together the results in Table 3 suggest that the market applies EoS processing to earnings news resulting in a primacy effect that accounts for a significant portion of the stock return penalty associated with missing analysts' earnings forecasts.

4. Archival research method, sample selection, descriptive statistics and results

4.1. Research design

Prior research reports empirical evidence of a market premium (penalty) for beating (missing) analysts' earnings forecasts independent of the level of the earnings surprise (Bartov et al., 2002; Brown & Caylor, 2005; Lopez & Rees, 2002). In addition, this literature reports that investors attach a significantly different weight (the earnings response coefficient) to positive and negative earnings surprises. Accordingly, we start our archival analysis with a model based on the work of Bartov et al. (2002), Lopez and Rees (2002) and Brown and Caylor (2005) as follows:

$$R_{it} = \sum_{k=1}^{48} \gamma k IND k + \alpha_1 BEAT_{it} + \alpha_3 MISS_{it} + \beta_1 PUE_{it} + \beta_2 NUE_{it} + \zeta_j X_{jit} + \delta_j X_{jit} * UE_{it} + \varepsilon_{it} \quad (4)$$

where:

R_{it} market-adjusted compounded abnormal returns extending from the day before to the day after the earnings announcement date for quarter t;
$MEET_{it}$ indicator variable coded 1 when actual earnings for firm i in quarter t is equal to the last analysts' forecast (LF_t); otherwise 0;
$BEAT_{it}$ indicator variable coded 1 when actual earnings for firm i in quarter t exceed the last analysts' forecast (LF_t); otherwise 0;
$MISS_{it}$ indicator variable coded 1 when actual earnings for firm i in quarter t fall below the last analysts' forecast (LF_t); otherwise 0;
UE $(E_t - LF_t) / P_{t-1}$; where LF_t is quarter t earnings forecast made closest to but before quarter t's earnings announcement date, and P_{t-1} is stock price as of the end of quarter $t-1$;
PUE_{it} UE_{it} if $UE_{it} > 0$, otherwise $PUE_{it} = 0$;
NUE_{it} UE_{it} if $UE_{it} < 0$, otherwise $NUE_{it} = 0$;
IND_k industry fixed effects for 48 Fama and French (1997) industry groupings; and
X_{jit} vector of control variables (growth, risk, size, loss and earnings permanence).

The control variables contained in X_j are growth, risk, size, loss and earnings permanence. Prior research reports that these variables are important determinants of the earnings response coefficient (Kormendi & Lipe, 1987; Collins & Kothari, 1989; Easton & Zmijewski, 1989; among others). Growth is defined as the market-to-book ratio as of the end of the earnings quarter. Risk is proxied by a firm's market model beta calculated using the CRSP equally-weighted market portfolio.[7] Firm size is the natural log of market value of equity. Loss is an indicator variable which equals one if the firm reported a loss for the quarter otherwise it is given a value of zero. Earnings persistence is measured consistent with Ali and Zarowin (1992) and Cheng, Liu, and Schaefer (1996). In particular, we rank firms each quarter by their E_{it}/P_{it} ratio where E_{it} is reported earnings per share for quarter t and P_{it} is the end-of-quarter price. All firms with negative values of E_{it}/P_{it} are assigned a ranking of 1 and the remaining observations are grouped into nine approximately equal portfolios and assigned a ranking of 2 through 10. As in the prior studies, the earnings persistence variable is set equal to one if the observation's ranking is from 3 to 8; otherwise, it is equal to zero. All other variables are as previously defined.

Bartov et al. (2002) and Kasznik and McNichols (2002) report evidence of a positive association between the sign of the earnings surprise (UE) and future earnings realizations. Thus, prior evidence suggests that the premium (penalty) observed for beating (missing) analysts forecast may be reflective of investors impounding into stock price expected future earnings. To control for this conjecture Eq. (4) is modified to include the firm's expectation of future earnings as follows:

$$R_{it} = \sum_{k=1}^{48} \gamma k IND k + \alpha_1 BEAT_{it} + \alpha_3 MISS_{it} + \beta_1 PUE_{it} + \beta_2 NUE_{it} + \lambda_1 FEPS\_0_{it} + \lambda_2 FEPS\_1_{it} + \zeta_j X_{jit} + \delta_j X_{jit} * UE_{it} + \varepsilon_{it} \quad (5)$$

where:

$FEPS\_0_{it}$ FE_y/P_{y-1}; FE_y is the median I/B/E/S analysts' forecast of year y earnings reported in the third month of quarter t, where year y is the year in which quarter t falls and P_{y-1} is stock price as of the beginning of year y (if quarter t is the 4th quarter in year y, then FE_y will be forecasted earnings for year $y+1$);

[7] The firm-specific beta was calculated using days −60 through −11 and +11 through +60 relative to the earnings announcement date.

$FEPS\_1_{it}$ FE_{y+1}/P_{y-1}; FE_{y+1} is the median I/B/E/S analysts' forecast of year $y+1$ earnings reported in the third month of quarter t, where year $y+1$ is the year subsequent to the year in which quarter t falls and P_{y-1} is stock price as of the beginning of year y (if quarter t is the 4th quarter in year y, then FE_{y+1} will be forecasted earnings for year $y+2$).

All other variables are as previously defined. $FEPS\_0_{it}$ and $FEPS\_1_{it}$ are the median I/B/E/S analyst forecast of earnings per share for the year of and the year subsequent to the year in which quarter t falls. We use the median I/B/E/S summary forecast of these future earnings amounts reported in the third month of quarter t. The future earnings forecasts are included to provide a direct empirical test of the association between beating or missing analysts' forecasts and future earnings suggested by Bartov et al. (2002) and Kasznik and McNichols (2002). If the expectation of future earnings explains the market premium (penalty) to beating (missing) forecasts, as suggested by the prior literature, we expect the coefficients on BEAT and MISS to converge toward zero with the inclusion of $FEPS\_0_{it}$ and $FEPS\_1_{it}$ in the model.

The primary objective is to empirically examine whether cognitive processing contributes to the premium (penalty) associated with beating (missing) analysts' earnings forecasts. Specifically, we examine whether, after controlling for the sign and magnitude of the earnings surprise as well as changes in the expectation of future earnings and earnings growth, the stock price premium (penalty) associated with beating (missing) analysts' forecasts is consistent with investors processing earnings news throughout the quarter in a "step-by-step" or "end-of-sequence" manner producing a recency or primacy effect.

To test for the cognitive processing method applied by market participants (SbS or EoS), we modify Eq. (6) by partitioning BEAT and MISS based on whether the last forecast of the period is greater (less) than the first forecast of the period (i.e., forecast revision). To partition BEAT and MISS, we create an additional variable REV, which is the forecast revision for the quarter measured as the difference between last forecast of the quarter made closest to but before quarter t's earnings announcement date actual earnings and the first forecast for quarter t that is made after the earnings announcement of quarter $t-1$. Using the sign of the forecast revision (REV) to partition BEAT and MISS, we modify Eq. (6) as follows:

$$R_{it} = \sum_{k=1}^{48} \gamma_k IND_k + \gamma_1 BEAT\_PREV_{it} + \gamma_2 BEAT\_NREV_{it} + \gamma_3 MISS\_PREV_{it} + \gamma_4 MISS\_NREV_{it} + \beta_1 PUE_{it} + \beta_2 NUE_{it} + \lambda_1 FEPS\_0_{it} + \lambda_2 FEPS\_1_{it} + \zeta_j X_{jit} + \delta_j X_{jit}{}^{*} UE_{it} + \varepsilon_{it} \quad (6)$$

where:

REV $(LF_t - FF_t) / P_{t-1}$; where LF_t is quarter t earnings forecast made closest to but before quarter t's earnings announcement date, FF_t is the first forecast of quarter t earnings made immediately after the earnings announcement date for quarter $t-1$ and P_{t-1} is stock price as of the end of quarter $t-1$.

$BEAT\_PREV_{it}$ indicator variable coded 1 if $UE_{it} > 0$ and $REV_{it} > 0$; otherwise 0;

$BEAT\_NREV_{it}$ indicator variable coded 1 if $UE_{it} > 0$ and $REV_{it} < 0$; otherwise 0;

$MISS\_PREV_{it}$ indicator variable coded 1 if $UE_{it} < 0$ and $REV_{it} > 0$; otherwise 0; and

$MISS\_NREV_{it}$ indicator variable coded 1 if $UE_{it} < 0$ and $REV_{it} < 0$; otherwise 0.

All other variables are as previously defined.[8]

A SbS process suggests that recency will dominate and predicts that BEAT_PREV will not be significantly different than BEAT_NREV after controlling for the magnitude of the positive earnings surprise (PUE). Similarly, a SbS process predicts that MISS_PREV will not be significantly different than MISS_NREV. A recency effect results when investors place greater reliance on the most recent information received, the earnings surprise. Thus, if a firm beats the most recent analyst forecast (a positive earnings surprise), a recency effect would predict that regardless of whether the firm had a positive or negative forecast revision the premium for beating the last analyst forecast will be the same after controlling for the magnitude of the earnings surprise.

On the other hand, an EoS process suggests that primacy will dominate and predicts that BEAT_PREV will be significantly greater than BEAT_NREV and MISS_PREV will be significantly greater than MISS_NREV. A primacy effect results when investors place significant reliance on the first piece (or amalgamation of earlier pieces) of information received. In the context of our study, the last piece of information, the earnings surprise, is evaluated in the context of earlier information, the forecast revision. Thus, an EoS process predicts that firms that report a positive earnings surprise with a positive forecast revision will be rewarded with a significantly greater market premium than firms that report a positive earnings surprise with a negative forecast revision. Similarly, an EoS process predicts that firms with a negative earnings surprise with a negative forecast revision will be penalized with significantly more negative market returns than firms that report a negative earnings surprise with a positive forecast revision.

Overall, the empirical predictions of SbS or EoS processing suggested by the estimation of Eq. (7) are as follows:

SbS(RECENCY)	EoS(PRIMACY)
$\gamma_1 = \gamma_2$	$\gamma_1 > \gamma_2$
$\gamma_3 = \gamma_4$	$\gamma_3 > \gamma_4$

4.2. Sample selection

To implement our archival research design, we require analysts' forecasts, actual earnings, price data to calculate returns (and to deflate our independent variables), and dates for when earnings forecasts are made and earnings are announced. We obtain actual quarterly earnings, analyst forecasts, and earnings announcement dates from Thomson Financial I/B/E/S for the 26 years extending from 1985 to 2010 and we obtain stock price and return data from CRSP.

To increase the power of our tests, we require that sample firms have an earnings forecast for quarter t within two weeks subsequent to the quarter $t-1$ earnings announcement date (FF_t). This procedure ensures that we capture virtually all of the total earnings news for quarter t that is disclosed during the quarter.[9] We define LF_t as the final quarter t earnings forecast prior to the quarter t earnings announcement date (Brown, 2001). However, if the most recent individual analyst forecast was made more than four weeks before the end of quarter t, we use the last published I/B/E/S consensus forecast before the earnings announcement date as our measure of LF_t.[10]

These procedures ensure that FF_t and LF_t are far enough apart in time so that analysts have sufficient opportunity to incorporate new earnings information into their earnings forecasts. The mean number of calendar days between FF_t and LF_t for our sample is approximately 69. Finally, to control for outliers and data errors, we eliminate observations in the one-percent tails for each variable employed in regression Eq. (6). These procedures result in a final sample of 106,992 firm-quarter observations (6507 unique firms).

[8] See Fig. 1 for illustration of forecast revision, earnings surprise and market return window.

[9] When there is more than one analyst forecast on the day of the first forecast, we take the mean of these analysts' forecasts to compute FF_t. We follow the same procedure when defining LF_t.

[10] Alternative procedures could be followed in defining LF; including, employing the latest consensus forecast for all observations. We perform a sensitivity analysis to assess the robustness of our results by employing this alternative specification and find quantitatively and qualitatively equivalent results to those reported in the tables.

4.3. Descriptive statistics

Table 4 presents the distribution of observations across years. The fewest observations are found in 1988 (358 observations representing 0.3% of the sample), while the most observations are found in 2008 (8674 representing 8.1% of the sample). Table 5 presents the descriptive statistics for the regression variables used in our empirical tests. Of particular interest are the results related to UE, the earnings surprise. The mean (median) earnings surprise pooled over time is 0.046 (0.042), which is consistent with recent evidence that suggests that firms more often than not report earnings that meet or beat analysts' forecast (Brown, 2001; Lopez & Rees, 2002). We also find that the mean (median) forecast revision for the quarter, REV, is −0.088 (0.000) suggesting that firms, on average, report bad news during the quarter. With respect to future earnings forecasts, we find that mean (median) values for FEPS_0 and FEPS_1 are 0.046 (0.052) and 0.062 (0.063), respectively.

4.4. Archival empirical results — base model — Eq. (5)

Our initial tests investigate the existence of a differential response for firm-quarter observations that beat analysts' forecasts compared to those that miss expectations. These tests essentially replicate the work of Bartov et al. (2002) and Lopez and Rees (2002). Table 6 presents the results for the pooled regression and mean coefficients from the 104 separate quarterly regressions of Eq. (5). The coefficient estimates from the pooled regression and mean coefficients from the 104 quarterly inter-temporal regressions are generally consistent.[11] Our discussion here, and throughout the manuscript, will rely on pooled cross-sectional regression results. The estimated slope coefficients, β_1 and β_2, suggest that stock prices are more sensitive to positive than negative earnings surprises at the earnings announcement date. The earnings response coefficients for firms that beat and miss analysts' expectations are 2.08 (β_1) and 0.54 (β_2), respectively. In a test of the difference between β_1 and β_2 (not tabulated) we find that β_1 is significantly greater than β_2 (two-tailed p-value < 0.01). These results are consistent with the results reported by Lopez and Rees (2002) and suggest that the market assigns significantly greater weight to positive than negative earnings surprises.

The results in Table 6 also indicate a significantly negative coefficient for MISS and a significantly positive coefficient for BEAT (two-tailed p-value < 0.01), which indicates that the sign of the earnings surprise is an important factor in the value formulation of the firm, independent of the magnitude of the earnings surprise (i.e., PUE and NUE) and the expectation of future earnings (FEPS_0 and FEPS_1). In fact, firms beating expectations experience a positive stock price reaction (premium) of 0.9% that is unrelated to the magnitude of unexpected earnings. Similarly, the coefficient on MISS indicates that firms that miss analysts' expectations experience a negative stock price reaction (penalty) of −2.1%. Controlling for cross-sectional dependence in the error terms, we find that all of the 104 of the separate quarterly regressions produce a coefficient that has the same sign for both MISS (negative) and BEAT (positive). The coefficient results reported for BEAT and MISS are essentially identical to the results reported by Lopez and Rees (2002) and Brown and Caylor (2005).

4.5. Empirical test of hypotheses H1 and H2 — Eq. (6)

Our next set of tests investigates a cognitive explanation for the premium (penalty) for beating (missing) analysts' earnings forecasts. Specifically, we examine whether the stock price premium (penalty) associated with beating (missing) analysts' forecasts is consistent with market participants processing earnings news throughout the quarter in a SbS or EoS manner, producing a recency or primacy effect. Prior behavioral research demonstrates that when individuals are presented with a series of information items, their decisions are systematically influenced by the way they process the individual pieces of evidence (Hogarth & Einhorn, 1992). A recency effect induced by SbS processing predicts that the premium (penalty) for beating (missing) analysts' forecasts will depend more on the relationship of the actual earnings news to the most recent forecast than to previously disclosed earnings news. On the other hand, a primacy effect induced by EoS processing predicts that investors will value the last piece of information (the earnings surprise) in the context of the first piece of information (the first forecast).

[11] The inter-temporal regressions are based on the methodology of Fama and MacBeth (1973) and are designed to control for cross-sectional correlation of the error term.

Table 4
Distribution of sample across years.

Year	Observations	Percentage
1985	636	0.60
1986	720	0.67
1987	638	0.60
1988	358	0.33
1989	857	0.80
1990	970	0.91
1991	1242	1.16
1992	1404	1.31
1993	1673	1.56
1994	2621	2.45
1995	2691	2.52
1996	3203	2.99
1997	3711	3.47
1998	4646	4.34
1999	5114	4.78
2000	4548	4.25
2001	5547	5.18
2002	6142	5.74
2003	6402	5.98
2004	6884	6.43
2005	7375	6.89
2006	7418	6.93
2007	8328	7.78
2008	8674	8.11
2009	8479	7.92
2010	6716	6.28
Total	106,992	100.00%

Table 5
Descriptive statistics (n = 106,992).

Variable	Mean	Median	Std. deviation
R	0.105	0.169	8.162
UE	0.046	0.042	0.510
REV	−0.088	0.000	0.404
FEPS_0	0.046	0.052	0.053
FEPS_1	0.062	0.063	0.043
MVE	5114	1213	14,468

Variable definitions are as follows:

R	percentage market-adjusted compounded abnormal returns extending from the day before to the day after the earnings announcement date for quarter t;
UE	$(E_t - LF_t) / P_{t-1}$ stated in percentage; where LF_t is quarter t earnings forecast made closest to but before quarter t's earnings announcement date, and P_{t-1} is stock price as of the end of quarter $t-1$.
REV	$(LF_t - LF_t) / P_{t-1}$; where LF_t is quarter t earnings forecast made closest to but before quarter t's earnings announcement date, FF_t is the first forecast of quarter t earnings made immediately after the earnings announcement date for quarter $t-1$ and P_{t-1} is stock price as of the end of quarter $t-1$.
FEPS_0	FE_y/P_{y-1}; FE_y is the median I/B/E/S analysts' forecast of year y earnings reported in the third month of quarter t, where year y is the year in which quarter t falls and P_{y-1} is stock price as of the beginning of year y (if quarter t is the 4th quarter in year y, then FE_y will be forecasted earnings for year $y+1$);
FEPS_1	FE_{y+1}/P_{y-1}; FE_{y+1} is the median I/B/E/S analysts' forecast of year $y+1$ earnings reported in the third month of quarter t, where year $y+1$ is the year subsequent to the year in which quarter t falls and P_{y-1} is stock price as of the beginning of year y (if quarter t is the 4th quarter in year y, then FE_{y+1} will be forecasted earnings for year $y+2$).
MVE	market value of equity as of the quarter end measured in millions of U.S. dollars.

Table 6
Empirical estimation of Eq. (5).

$$\text{Eq.(5)}: R_{it} = \sum_{k=1}^{48} \gamma k \text{IND}k + \alpha_1 \text{BEAT}_{it} + \alpha_3 \text{MISS}_{it} + \beta_1 \text{PUE}_{it} + \beta_2 \text{NUE}_{it} + \lambda_1 \text{FEPS\_0}_{it} + \lambda_2 \text{FEPS\_1}_{it} + \zeta_j X_{jit} + \delta_j X_{jit} * \text{UE}_{it} + \varepsilon_{it}.$$

Variable	Predicted sign	Pooled regression	Inter-temporal regressions
BEAT	+	0.927	0.671
		(21.84)***	(5.88)***
MISS	−	−2.070	−1.904
		(−39.25)***	(−10.22)***
PUE	+	2.083	2.111
		(27.94)***	(11.02)***
NUE	+	0.536	0.507
		(8.04)***	(4.94)***
FEPS_0	+	0.034	0.039
		(10.82)***	(4.75)***
FEPS_1	+	0.005	0.008
		(0.48)	(1.16)
N		106,992	104

R	market-adjusted compounded abnormal returns extending from the day before to the day after the earnings announcement date for quarter t;
MEET	indicator variable coded 1 when actual earnings equals the analysts' forecasts; otherwise MEET = 0;
BEAT	indicator variable coded 1 when actual earnings exceed analysts' forecasts; otherwise, BEAT = 0;
MISS	indicator variable coded 1 when actual earnings fall below analysts' forecasts; otherwise, MISS = 0;
UE	$(E_t - LF_t) / P_{t-1}$; where LF_t is quarter t earnings forecast made closest to but before quarter t's earnings announcement date, and P_{t-1} is stock price as of the end of quarter $t-1$;
PUE	indicator variable coded UE if UE > 0, otherwise PUE = 0;
NUE	indicator variable coded UE if UE < 0, otherwise NUE = 0;
IND_k	industry fixed effects for 48 Fama and French industry groupings;
X_{jit}	vector of control variables (growth, risk, size, loss and earnings permanence);
FEPS_0	FE_y/P_{y-1}; FE_y is the median I/B/E/S analysts' forecast of year y earnings reported in the third month of quarter t, where year y is the year in which quarter t falls and P_{y-1} is stock price as of the beginning of year y (if quarter t is the 4th quarter in year y, then FE_y will be forecasted earnings for year $y+1$); and
FEPS_1	FE_{y+1}/P_{y-1}; FE_{y+1} is the median I/B/E/S analysts' forecast of year $y+1$ earnings reported in the third month of quarter t, where year $y+1$ is the year subsequent to the year in which quarter t falls and P_{y-1} is stock price as of the beginning of year y (if quarter t is the 4th quarter in year y, then FE_{y+1} will be forecasted earnings for year $y+2$).

*** Two-tailed p-value < 0.01.
** Two-tailed p-value < 0.05.
* Two-tailed p-value < 0.10.

Eq. (6) expands Eq. (5) by partitioning BEAT and MISS based on whether the last forecast of the quarter is greater (less) than the first forecast of the period (i.e., the sign of the forecast revision). BEAT_PREV is equal to 1 when the earnings surprise is positive and the forecast revision earlier in the quarter (REV) is positive. The variable BEAT_NREV is equal to 1 when the earnings surprise is positive and the forecast revision is negative. MISS_PREV is equal to 1 when the earnings surprise is negative and the forecast revision is positive. MISS_NREV is equal to 1 when the earnings surprise is negative and the forecast revision is negative. Table 7 presents the results for the pooled cross-sectional regression and separate quarterly regressions of Eq. (6).

The results in Table 7 indicate significantly negative coefficients for MISS_NREV and MISS_PREV and significantly positive coefficients for BEAT_PREV and BEAT_NREV (two-tailed p-value < 0.01). These results are interesting because prior research suggests that investors provide a premium (penalty) for beating (missing) earnings expectations (independent of the magnitude of the earnings surprise). Our results confirm that conclusion even after controlling for prior earnings news (i.e., the forecast revision). Table 8 reports tests of coefficient differences from the estimation of Eq. (6). We first test the difference between the coefficients on BEAT_PREV and BEAT_NREV (γ_1 and γ_2). SbS processing (recency) predicts no difference in these coefficients, while EoS processing (primacy) predicts that the coefficient on BEAT_PREV will be significantly greater than the coefficient on BEAT_NREV (i.e., $\gamma_1 > \gamma_2$). Consistent with H1, we find that the coefficient on BEAT_PREV of 1.2% is significantly greater than the coefficient on BEAT_NREV of 0.5% (two-tailed p-value < 0.01). Moreover, the coefficient on BEAT_PREV of 1.2% is 62.0% greater than the coefficient on BEAT_NREV of 0.5%.

We next examine the difference between the coefficient on MISS_PREV and MISS_NREV (γ_3 and γ_4). SbS processing (recency) predicts no difference, while EoS processing (primacy) predicts that the coefficient on MISS_PREV (γ_3) will be significantly greater than the coefficient on MISS_NREV (γ_4). Consistent with H2, we find that the coefficient on MISS_PREV (γ_3) of −0.8% is significantly greater (two-tailed p-value < 0.01) than the coefficient of −2.2% on MISS_NREV (γ_4). In addition, the −0.8 coefficient on MISS_PREV is 62.3% greater than the −2.2 coefficient on MISS_NREV. Taken together, our results suggest that the market applies EoS processing to earnings news resulting in a primacy effect that accounts for a significant portion of the stock return premium (penalty) associated with the sign of earlier earnings news (i.e., the forecast revision).

5. Sensitivity tests

We perform three additional tests to assess the robustness of our results. First, we reestimate each regression equation utilizing a return window that runs from the date of the last analyst earnings forecast to the day after the earnings announcement. In addition, we reestimate each regression equation utilizing a return window that extends from two days following the first forecast of quarter t following the announcement of earnings for quarter $t-1$ to one day following the announcement of earnings for quarter t (Bartov et al., 2002). The results of these additional tests, not tabulated, are quantitatively and qualitatively similar to those reported in the tables. Each of our conclusions are unaffected by the use of these alternative returns measures.

Second, we re-estimate each regression equation utilizing the first (FF) and last (LF) IBES consensus forecasts of the quarter rather than the first and last individual forecasts of the quarter. The results of these additional tests, not tabulated, are quantitatively and qualitatively similar to those reported in the tables. Again, each of our conclusions are unaffected by the use of this shorter window abnormal return measure.

6. Conclusion

We examine whether the association between earnings announcement period stock returns and contemporaneous earnings news is influenced by previously disclosed earnings news. Our primary conclusion is that investors' response to the earnings surprise (actual earnings less

Table 7
Empirical Estimation of Eq. (6).

$$\text{Eq. (6)}: R_{it} = \sum_{k=1}^{48} \gamma k IND k + \gamma_1 BEAT\_PREV_{it} + \gamma_2 BEAT\_NREV_{it} + \gamma_3 MISS\_PREV_{it} + \gamma_4 MISS\_NREV_{it} + \beta_1 PUE_{it} + \beta_2 NUE_{it} + \lambda_1 FEPS\_0_{it} + \lambda_2 FEPS\_1_{it} + \zeta_j X_{jit} + \delta_j X_{jit} * UE_{it} + \varepsilon_{it}.$$

Variable	Prediction	Pooled cross-sectional coefficients (*t*-statistics)	Mean inter-temporal coefficients (*t*-statistics) from quarterly regressions
BEAT_PREV	+	1.224 (26.82)***	0.853 (7.18)***
BEAT_NREV	?	0.465 (6.02)***	0.167 (1.55)
MISS_PREV	?	−0.838 (−5.71)***	−0.879 (−5.90)***
MISS_NREV	−	−2.225 (−41.23)***	−2.063 (−11.43)***
PUE	+	2.154 (25.96)***	1.995 (10.62)***
NUE	+	0.486 (7.22)***	0.441 (5.00)***
FEPS_0	+	0.033 (9.96)***	0.038 (4.39)***
FEPS_1	+	0.001 (0.09)	0.007 (0.96)
n		106,992	104

R market-adjusted compounded abnormal returns extending from the day before to the day after the earnings announcement date for quarter *t*;
MEET indicator variable coded 1 when actual earnings equals the analysts' forecasts; otherwise MEET = 0;
REV $(LF_t - LF_t) / P_{t-1}$; where LF_t is quarter *t* earnings forecast made closest to but before quarter *t*'s earnings announcement date, FF_t is the first forecast of quarter *t* earnings made immediately after the earnings announcement date for quarter $t-1$ and P_{t-1} is stock price as of the end of quarter $t-1$;
BEAT indicator variable coded 1 when actual earnings exceed analysts' forecasts; otherwise, BEAT = 0;
MISS indicator variable coded 1 when actual earnings fall below analysts' forecasts; otherwise, MISS = 0;
BEAT_PREV indicator variable coded 1 if UE is greater than zero and REV is *greater* than zero; otherwise BEAT_PREV = 0;
BEAT_NREV indicator variable coded 1 if UE is greater than zero and REV is less than zero; otherwise BEAT_NREV = 0;
MISS_PREV indicator variable coded 1 if UE is less than zero and REV is greater than zero; otherwise MISS_PREV = 0;
MISS_NREV indicator variable coded 1 if UE is less than zero and REV is less than zero; otherwise MISS_NREV = 0;
UE $(E_t - LF_t) / P_{t-1}$; where LF_t is quarter *t* earnings forecast made closest to but before quarter *t*'s earnings announcement date, and P_{t-1} is stock price as of the end of quarter $t-1$;
PUE indicator variable coded UE if UE > 0, otherwise PUE = 0;
NUE indicator variable coded UE if UE < 0, otherwise NUE = 0;
IND_k industry fixed effects for 48 Fama and French industry groupings;
X_{jit} UE interacted with a vector of control variables (growth, risk, size, loss and earnings permanence) identified in the prior literature as cross-sectional determinants of earnings response coefficients;
FEPS_0 FE_y/P_{y-1}; FE_y is the median I/B/E/S analysts' forecast of year *y* earnings reported in the third month of quarter *t*, where year *y* is the year in which quarter *t* falls and P_{y-1} is stock price as of the beginning of year *y* (if quarter *t* is the 4th quarter in year *y*, then FE_y will be forecasted earnings for year $y+1$); and
FEPS_1 FE_{y+1}/P_{y-1}; FE_{y+1} is the median I/B/E/S analysts' forecast of year $y+1$ earnings reported in the third month of quarter *t*, where year $y+1$ is the year subsequent to the year in which quarter *t* falls and P_{y-1} is stock price as of the beginning of year *y* (if quarter *t* is the 4th quarter in year *y*, then FE_{y+1} will be forecasted earnings for year $y+2$).

*** Two-tailed p-value < 0.01.
** Two-tailed p-value < 0.05.
* Two-tailed p-value < 0.10.

the last forecast of the quarter) is conditional on the sign of prior earnings news (i.e., the forecast revision). We develop and test predictions based on behavioral theories of how investors will react to a series of earnings information.

Our study provides two contributions. First, it extends the literature on individual belief revision to an empirical market setting. Prior experimental research indicates that when individuals are presented with a series of information items, their decisions are systematically influenced by how they process the information (Hogarth & Einhorn, 1992). However, economic theory suggests that in a market context, the method of information processing should be an irrelevant factor in the pricing decision. The competitive process inherent in the market is thought to influence how market participants formulate and revise their beliefs, mitigating or even eliminating cognitive strategies. The results of this study suggest that individual cognitive strategies survive the capital market aggregation process and significantly contribute to the overall market valuation of earnings-related news.

Second, the results of our study also have important implications for the valuation of an earnings surprise. The literature suggests that the market provides a premium for firms that beat analysts' earnings forecasts (e.g., Lopez & Rees, 2002). In addition, the extant literature reports that managers often guide analysts' forecasts downward in order to meet or beat expectations (Matsumoto, 2002). Our results suggest that both managers and analysts might want to reconsider the process

Table 8
Test of coefficient differences from the estimation of Eq. (6).

$$\text{Eq.(6)}: R_{it} = \sum_{k=1}^{48} \gamma k IND k + \gamma_1 BEAT\_PREV_{it} + \gamma_2 BEAT\_NREV_{it} + \gamma_3 MISS\_PREV_{it} + \gamma_4 MISS\_NREV_{it} + \beta_1 PUE_{it} + \beta_2 NUE_{it} + \lambda_1 FEPS\_0_{it} + \lambda_2 FEPS\_1_{it} + \zeta_j X_{jit} + \delta_j X_{jit} * UE_{it} + \varepsilon_{it}.$$

Test	Primacy predicts	Pooled estimate *t*-statistics	Inter-temporal *t*-statistics
H1: BEAT_PREV–BEAT_NREV	$\gamma_1 > \gamma_2$	0.759 (8.04)***	0.686 (5.69)***
H2: MISS_NREV–MISS_PREV	$\gamma_4 < \gamma_3$	−1.387 (−9.56)***	−1.184 (−7.14)***

Note: Variable definitions are reported in Table 7.
*** Two-tailed p-value < 0.01.
** Two-tailed p-value < 0.05.
* Two-tailed p-value < 0.10.

of analyst forecast guidance since the manner in which a positive surprise is arrived at (i.e., prior earnings news) has significant market valuation implications for the earnings surprise.

Appendix A. Subject instructions

Welcome. We hope you have fun, earn some money, and learn something today. You will participate in a simulated stock market where you buy and sell shares of stock in different hypothetical companies. Just like a real stock market, you should pay close attention to the information you receive because you will actually be paid a percentage of your profits in *cash* at the conclusion of the experiment. In order to earn more *cash*, your goal should be to maximize your *total profit*. We will explain later exactly how you can earn profits.

Trading will occur for *eight* companies. The eight companies are named Company A, Company B, Company C, Company D, Company E, Company F, Company G, and Company H.

Trading will occur for only *one* company at a time. Since there are eight companies, there will be *eight trading sessions* in total, one session for each company.

Trading for Company A will be a *practice trading session*, in which your decisions will *not* affect your profits. This *practice trading session* is to help you get familiar with the computer program. You should feel free to use Company A to concentrate on learning how to trade.

Trading sessions for the remaining companies (Company B, C, D, E, F, G, and H) *will* affect your profits.

As mentioned above, a *trading session* will consist of trading for only *one* company. Each trading *session* will last 7.5 min in total.

At the beginning of each trading *session* for a company, you will receive five shares of stock and 150 "experimental" dollars ($100 of which is an interest free loan and $50 of which you will keep toward your profits).

Each trading *session* and will be divided into a number of *trading periods*. There are multiple trading *periods* in each trading *session*.

During each trading *period* for each company, you may *buy*, *sell*, and/or *keep* your shares of stock. At the beginning of each trading *period*, you will receive *one* piece of trading information and have some time to trade on this information.

All information for each trading *period* is available to everyone in the market at the *same time*.

The information you will receive during each trading *period* are called *forecasts*. These *forecasts* are about each company's *forecasted* dividends.

A new trading *period* begins when a new *forecast* is made available to everyone in the market.

When a new trading *period* begins, any prior *open bids* and *open asks* will be cleared. An *open bid* is an offer to *buy* a share of stock that is *not* accepted by any seller in a prior trading *period*. An *open ask* is an offer to *sell* a share of stock that is *not* accepted by any buyer in a prior trading *period*.

Each company will pay a dividend at the end of the trading *session*. The amount of the dividend is uncertain, but you can use the information you will be provided to help predict the dividend at the end of the trading session.

The *forecasts* you receive may cause you to revise your estimate of what the dividend is likely to be at the end of the trading *session*. When you receive this information, you might consider revising your estimate of the appropriate stock price. However, whether you revise your estimate of the expected dividend payout, how much you revise your estimate, and whether you trade is ultimately up to you in your discretion as an investor in the market.

Prior studies demonstrate that *forecasts* tend to become *more accurate* the closer they are in time to the actual dividend announcement. Consistent with this research, this tendency is incorporated in this experiment. That is, in forming your own estimate of the dividend, you can assume that the *last* forecast of dividends is more accurate than the *first*. However, the amount of the dividend remains uncertain. It is your job to use the information provided to predict the final dividend.

You will be able to earn profits in one of two ways, by *trades* and/or by *dividends*.

Trades: You may sell one or more of the shares you were given at the beginning of each trading session, or hold them and collect the dividend. You may also buy shares and hold them to collect the dividend. You may also sell any shares that you have purchased. Any money you earn from selling shares above the amount you paid to purchase the share contributes to your profits.

Dividends: At the conclusion of each trading session, the company will buy back any shares you own. This buy back is called a "liquidating" dividend and is announced after the trading is complete.

The more accurately you predict the liquidating dividend for each trading session, the more you will make from your buy, sell and hold decisions.

Cash payout: At the conclusion of the experiment (after all companies have been traded), you will be paid in direct proportion to the amount of experiment dollars you have earned. One hundred experiment dollars will be converted into $1.00 US. Your total earnings in experiment dollars is the sum of your earnings from trades and dividends for companies B, C, D, E, F, G and H (trade in Company A is for practice only).

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