Oh What a Beautiful Morning!

Diurnal Variations in Executives' and Analysts' Behavior: Evidence from Conference Calls

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Abstract

This study provides novel evidence that expert economic agents' work-related behavior is systematically influenced by diurnal rhythms. We use archival data derived from time-stamped quarterly earnings conference calls—the main communication venue between companies and their shareholders—together with linguistic algorithms to measure and track the moods of executives and analysts at different times of the day. The evidence indicates that the tone of conference call discussions deteriorates markedly over the course of the trading day, with both analysts' and executives' moods becoming more negative as the day wears on. Furthermore, capital market pricing tests reveal that the diurnal-rhythm-induced negative tone in afternoon calls leads to temporary stock mispricings. Our study contributes to the economics literature as the diurnal variations in behavior documented in the context of quarterly earnings calls are likely to extend across numerous other corporate communications, decision-making, and performance situations, leading to potentially significant economic consequences.

JEL Codes: G02, G14, M41

Key Words: Diurnal rhythms, circadian rhythms, behavioral economics, conference calls, textual analysis, abnormal returns, management communication, economic decision-making

1. Introduction

Most of us sense that our moods, physical energy levels, and cognitive functioning skills vary over the course of the day, and a substantial body of psychological and physiological literature scientifically confirms this (e.g., Freeman and Hovland (1930); Folkard (1975); Watts, Cox, and Robson (1983); Wood and Magnello (1992); Stone, Smyth, Pickering, and Schwartz (1996); and Blatter and Cajochen (2007)). Due to a confluence of factors including mental fatigue, declining glucose levels, and the impact of circadian rhythms on brain wave activity, hormone production, cell regeneration and other aspects of cognitive function and biological activity, human behavior is decidedly variable along many dimensions over the 24-hour circadian cycle. Although this time-induced variability is likely to have significant economic implications when considered in the context of managerial communications, negotiations, decision-making, and other aspects of professional performance, we are unaware of any prior studies that have examined the influence of diurnal rhythms in a corporate setting. We address this deficiency in the literature by investigating the impact of diurnal rhythms on expert economic agents' behavior in one very consequential corporate-capital markets context: the regularly recurring and highly consequential quarterly earnings conference call discussions between the firm's top executives and their most important investors and analysts. Our extensive archival study relies upon more than 15,000 conference call transcripts and provides the first evidence of systematic diurnal influences impacting a major corporate activity.

The participants in corporate quarterly conference calls typically include the CEO and CFO, as well as some of the firm's other senior executives, together with the buy- and sell-side financial analysts that cover the firm. These routine and ubiquitous calls have become the main communication venue between companies and investors. Furthermore, these communication events have important economic consequences as prior studies have shown that calls are associated with increased stock trading, volatility, and abnormal price changes (Frankel, Johnson, and Skinner (1999); and Bushee, Matsumoto, and Miller (2003), amongst others), and they also affect the post-call price formation process (Kimbrough (2005)) because the call conversations elicit new information about the firm's economic prospects (Matsumoto, Pronk, and Roelofsen (2011)). Thus, the earnings calls underlying our sample involve economically sophisticated, highly motivated, and presumed rational expert economic agents engaged in an important aspect of their

professional duties. Given this, our setting may be considered, *a priori*, an unlikely one in which to detect diurnal influences on behavior (i.e., call participants represent the near embodiment of the idealized *homo economicus*). Notwithstanding this, we find strong evidence that the behavior of even these expert economic agents is significantly influenced by diurnal rhythms.

Our enquiry into the impact of the time-of-day in an economic setting is motivated by the burgeoning research of biological rhythms (Foster and Kreitzman (2005)), which documents the influence of diurnal effects on human behavior in various general or particular contexts. Recent studies in communications, for example, use hundreds of millions of "tweets" to document that tweeters' moods vary throughout the day, with early morning and late evening showing the highest levels of happy tweets[1] (Mislove, Lehmann, Ahn, Onnela, and Rosenquist (2010); Golder and Macy (2011)). Diurnal rhythms also have important consequences in the context of more professional decision-making and performance situations, such as the judiciary and medicine. Danziger, Levav, and Avnaim-Pesso (2011), for example, find that judges' parole decisions vary in a predictable manner over the course of the day, while Dai, Milkman, Hofmann, and Staats (2015) and Linder, Doctor, Friedberg, Nieva, Birks, Meeker, and Fox (2014) respectively document the disturbing finding that each of nurses' and doctors' professional performances deteriorate as the day wears on.

The influence of the time-of-day documented in these and other experimental and behavioral studies is explained in part by two lines of research in the fields of psychology and physiology: "personal resources" theory and the study of circadian rhythms' influence on human biology and behavior. A core underlying assumption of the personal resources framework is that individuals have a limited "reservoir" of resources from which to draw in order to adequately perform the variety of demands and activities that they face throughout the day. As these resources are depleted over the course of the work-day, individuals exhibit poorer task performance, greater hostility, and more aggressive interaction and communication (DeWall, Baumeister, Stillman, and Gailliot (2007); Hagger, Wood, Stiff, and Chatzisarantis (2010); Stucke and Baumeister (2006)). In addition to our limited resources, humans (like most other living beings, including plants, animals, fungi, and cyanobacteria) are also significantly affected by the roughly 24-hour circadian (*circa*,

[1] A "tweet" is a text message of 140 characters or less sent on Twitter, an online social networking and microblogging service. As of August 2014, Twitter has 271 million monthly active users who send 500 million tweets per day (source: https://about.twitter.com/company, referenced August 28th, 2014).

about; *diem*, a day) cycle. Circadian rhythms affect human biology, emotions, and cognitive function, and the diurnal variations that they induce are not trivial; by some estimates, depending on the task, the performance change between the daily high and low points can be equivalent to the effect on performance of drinking the legal limit of alcohol (Foster and Kreitzman (2005)). The potential economic consequences associated with decision-making and performance under the influence of these diurnal rhythms are therefore likely to be significant.

Our setting of corporate earnings conference calls is an excellent context in which to investigate the potential influence of diurnal rhythms on economic behavior for at least the following reasons: i) the calls are extremely important corporate communication events (Frankel et al. (1999); Skinner (2003)), evidenced by the fact that practically all calls are conducted by the CEO and CFO – i.e., there is no delegation to underlings when it comes to conference calls (Lev (2012)); ii) they are reliably time-stamped; iii) call transcripts are readily available for linguistic sentiment analysis, enabling us to capture the mood of these communications using scientific methods; iv) the calls have important economic consequences (i.e., share price effects); v) all parties to the call conversations can be presumed to be economically sophisticated and highly motivated; and vi) as an important complement to the prior research related to diurnal influences on human behavior, which is typically based upon small sample simulated situations in the laboratory or reconstructed from self-reported diaries, our findings are derived from a large sample of *archival* data consisting of actual, regularly recurring discussions between public company executives and Wall Street analysts.

Using a sample of more than 15,000 earnings call transcripts, we find reliable evidence that the behavior of the expert economic agents participating in these quarterly earnings conference calls is significantly influenced by diurnal rhythms. Specifically, the mood of participants on calls initiated in EST and CST time zones deteriorates during the day, becoming increasingly negative as the trading day wears on. Furthermore, the influence of these diurnal rhythms on the tone of conversation is apparent for both analysts and executives. Extensive specification checks establish that our key results are robust to controls for potential endogeneity in the self-selection of afternoon call times and to the omission of firm-specific variables that may be correlated with call start times. Further tests show that the effect of the time-of-day on mood is exacerbated for West Coast calls, a finding that we attribute to the more advanced body clocks of some of these calls' participants. Perhaps more consequentially, our results are confirmed by market pricing tests. 5-hour intraday

returns tests show that share prices decline in response to the negative mood of Q&A discussions. However, consistent with afternoon call tone being "excessively" negative (i.e., in the sense that a portion of it is driven by human mood rather than economic fundamentals), our longer-term stock returns analyses indicate that the market eventually realizes that some portion of afternoon call tone is value-irrelevant. Accordingly, the initial negative returns associated with the time-of-day-induced negativity, what we label "diurnal tone," are subject to subsequent price reversals. Thus, an important insight that emerges from our study is that investors do not quickly sort between human-mood- versus economics-driven tone, which leads to economic consequences in the form of temporary stock mispricings for firms hosting earnings calls later in the day. By implication, an important takeaway from our study for corporate executives is that communications with investors, and probably other critical managerial decisions and negotiations, should be conducted earlier in the day.

Both the circadian rhythms underlying the behavior being investigated in our study, as well as seasonal influences on human psychology, are intimately intertwined with the effects of daylight on moods and biological processes. Our study is therefore closely related to the strand of behavioral economics research that documents the effects of seasonal variations on financial market participants. Kamstra, Kramer, and Levi (2000), for example, present evidence to suggest that daylight savings time changes affect stock trading, while Hirshleifer and Shumway (2003) and deHaan, Madsen, and Piotroski (2015) document relations between stock returns and analyst behavior, respectively, and the weather. Kamstra, Kramer, and Levi (2003), amongst others, also find that seasonal affective disorder (SAD) influences behavior in financial settings. Our study builds upon this literature in several important ways. First, most of the prior studies in this area relate seasonal variations in the weather or daylight hours to a *summary measure* of beliefs (e.g., stock returns). By contrast, the composition our data enables us to examine the moods of the actual call participants whose behavior is hypothesized to be affected by diurnal rhythms, rather than relying upon an aggregated outcome measure from which to draw inferences. Second, as an important complement to the prior studies related to *seasonal* influences on financial market participants, our study provides novel evidence related to the influence of the shorter and much more regularly recurring *diurnal* cycle on economic behavior.

Based upon the results presented, we conclude that even expert economic agents operating in highly incentivized situations are subject to significant diurnal influences. Our particular setting

enables us to establish reliable associations between the time-of-day and the moods of executives and analysts on conference calls, and between the tone of their conversations and stock returns. While these findings are important in their own right, we believe that our results have greater significance. When considered together with extensive prior psychological evidence from the laboratory, the archival findings presented here are indicative of a much more pervasive phenomenon of diurnal rhythms influencing corporate communications, decision-making and performance across all employee ranks and business enterprises throughout the economy.

The remainder of the paper is organized as follows: Section 2 discusses prior related psychological literature, provides some institutional background related to corporate conference calls, and motivates our principal research question. Section 3 describes our sample, data sources and variable measurements. Section 4 provides empirical evidence, including a battery of robustness checks, that the time-of-day influences the behavior of analysts and executives participating in corporate conference calls. Section 5 summarizes and concludes the study.

2. Background and Hypothesis Development

2.1 Seasonal Variations in Financial Market Participants' Behavior

Our study relates most closely to the behavioral economics literature that documents the influence of seasonal variations on financial market participants' decision-making and behavior. Kamstra et al. (2000), for example, present evidence of an anomalous daylight savings effect on stock returns. They conjecture that the sleep disruption induced by a changing of the clock (known to sleep experts as a desynchronosticity in circadian rhythm) causes market participants to suffer greater anxiety, ultimately leading them to shun risk during the trading day following a time change.

Kamstra et al. (2003) and Kamstra, Kramer, and Levi (2012), amongst others, document a relation between seasonal affective disorder (SAD) and stock market cycles. Relying on the established psychological links between reduced daylight hours and depression, and between depression and risk aversion, these authors present evidence that reduced daylight hours help to explain lower returns in winter months. Dolvin, Pyles, and Qun (2009) suggest that SAD also affects analyst behavior, as they present evidence that analyst estimates are significantly less

optimistic during SAD months, and especially so for analysts in northern states who are most likely to be impacted by this disorder.

In a similar vein, Hirshleifer and Shumway (2003) establish a strong correlation between stock returns and the weather, which they attribute to the well-known psychological result that sunny weather is associated with an upbeat mood. Relatedly, deHaan et al. (2015) document that analysts experiencing unpleasant weather are less likely to update their reports following an earnings announcement, a finding that they attribute to weather-induced bad moods impeding the efficiency of market participants' response to earnings news.

All of these studies suggest that, contrary to the notions of *homo economicus* and efficient capital markets, even financial experts are vulnerable to seasonally-induced variations in their decision-making and behavior. Our study builds upon this literature by considering the influence of the more regularly recurring *daily* rhythms on economic behavior, and by establishing a more direct link between these rhythms and the moods of actual economic agents in the capital markets (i.e., rather than examining a summary outcome measure of their decision processes).

2.2 Diurnal Variations in Human Behavior

A substantial body of psychological and physiological research documents that human emotions, energy, mental reasoning, physiological processes, and other aspects of behavior and performance are characterized by significant diurnal variations (e.g., Freeman and Hovland (1934); Colquhoun (1971); Folkard (1975); Minors and Waterhouse (1981); Watts, Cox and Robson (1983); Wood and Magnello (1992); Stone et al. (1996); Foster and Kreitzman (2005)). Two principal areas of research in the fields of psychology and physiology that help to explain the impact of the time-of-day are "personal resources theory" and the study of circadian rhythms' effects on human emotions, biology, cognitive performance, and other aspects of behavior.

The concept of personal resources has found growing attention in research on emotion and behavioral performance. A core underlying assumption of this framework is that individuals have a limited "reservoir" of resources from which to draw in order to adequately perform the variety of demands and activities that they face throughout the day. Expending effort on work results in load reactions that deplete energy resources over time (Meijman and Mulder (1998)). As these resources are depleted over the course of the work-day, individuals exhibit poorer task performance, greater hostility, and more aggressive interaction and communication (DeWall et al.

(2007); Hagger et al. (2010); Stucke and Baumeister (2006)). Furthermore, people are motivated to protect their personal resources, such that the reduction and loss of resources creates tension and stress because resource loss is more salient than resource gain (Hobfoll (1989, (1998)). Another prominent theory of personal resources is the strength model of self-control (Baumeister, Bratslavksy, Muraven, and Tice (1998); Muraven and Baumeister (2000); Baumeister (2002)), which argues that an individual's capacity to regulate the self and maintain deliberate control over their actions is a limited commodity. As this capacity is depleted over time, self-regulation is reduced and there is an increased risk of unconstrained and impulsive behavior (Muraven and Baumeister (2000)). This finding is particularly relevant to our context of earnings conference calls because of the importance of these calls and their share price effects, which presumably motivates participants to exhibit restraint and self-control. All of these theories suggest that as individuals' resources become depleted over the course of the workday, their performance will decline and their moods will become more negative.

In addition to the effects of depleting resources, the circadian clock also influences human behavior over the course of a day. Circadian rhythms affect brain wave activity, hormone production, cell regeneration and other human biological processes. Moods, or positive and negative affects, are similarly affected by diurnal rhythms (Stone et al. (1996)). Wood and Magnello (1992) document self-reported deterioration in the moods of their subjects as the day wears on, for example, while Hasler, Mehl, Bootzin, and Vazire (2008) find that utterances and verbal behavior associated with positive affect (such as laughing or singing) recorded in natural settings show systematic time-of-day variation. Circadian rhythms are also inherent in basic neurobehavioral measures such as attention, working memory, and executive functions (Blatter and Cajochen (2007)), and therefore influence performance on tasks requiring cognitive skills (see, e.g., Freeman and Hovland (1930); Colquhoun (1971); Folkard (1975); or Foster and Kreitzman (2005) for a summary).

In the specific context of communications, Mislove et al. (2010) uses over 300 million "tweets" to document that tweeters' moods vary throughout the day, with early morning and late evening showing the highest levels of happy tweets. They further show that West Coast tweets follow a pattern that is consistently three hours behind that of the East Coast, strongly suggesting that individuals' moods are affected by the diurnal cycle. In a related study, Golder and Macy (2011) document similar patterns from the Twitter messages of 2.4 million people in 84 countries. Their

cross-cultural findings confirm that people around the world experience similar moods at similar times of day.

Numerous studies have also established that even highly trained professionals are subject to the influences of diurnal rhythms and resource depletion in their work-related performance. For example, Danziger et al. (2011) hypothesize and find that judges are more likely to deny parole (i.e., to take the safer, easier decision option) as court sessions wear on, a finding that they attribute to the judges' mental and physical depletion. Similarly, Dai, Milkman, Hofmann, and Staats (2015) investigate the influence of time-at-work on "one of the most significant compliance challenges in health care today: hand hygiene" (page 846) and find that compliance rates drop significantly from the beginning to the end of nurses' work shifts. Perhaps most shockingly, Linder et al. (2014) document that the cumulative cognitive demand of repeated decisions throughout the day seems to erode medical clinicians' abilities to resist making potentially inappropriate choices. In their study of more than 20,000 acute respiratory infections, they find that as the day wears on, doctors become increasingly more likely to prescribe antibiotics even when they are not indicated. All of these studies support the notion that the work-related performance of even the most highly trained experts varies – and notably that judgment and decision-making skills deteriorate - over the course of the workday. To the best of our knowledge, however, ours is the first study to investigate these diurnal influences on expert economic agents acting in a real and important corporate setting.

2.3 Corporate Conference Calls

A unique feature of our study is that our subjects, corporate top executives, in particular, are *a priori* the least expected to be subject to time-of-day effects. They are well aware of the importance of conference calls, and prepare themselves meticulously for this engagement, often with the help of specialized coaches. One would not expect these agents to be subject to diurnal influences. Earnings-related conference calls are ubiquitous and typically conducted within a few hours to a day following the much anticipated quarterly earnings press release. These calls are considered to be one of the most important corporate communication events (Frankel et al. (1999); Skinner (2003); Corbin Perception (2015)), and consist of an uninterrupted managerial presentation followed by a question-and-answer ("Q&A") session with analysts and investors. The

presentation portion of the call often involves several of the company's top executives largely rehashing the main content of the earnings press release (Kimbrough (2005)). By contrast, the Q&A consists of a live discussion between agents who are internal and external to the firm, and ecause of its conversational nature, the Q&A elicits new information beyond that contained in the earnings press release. Indeed, studies have shown that the Q&A discussion is the most economically important aspect of the calls. Matsumoto, Pronk & Roelofsen (2011) report, for example, that while both the management presentation and Q&A portions of the call offer some incremental information beyond the earnings announcement (as evidenced by intraday abnormal returns during the call period), the Q&A offers relatively more new information content. Furthermore, the more extemporaneous quality of the Q&A lends it greater power as a setting in which to detect diurnal influences. Accordingly, we use this conversational component of earnings calls to investigate the influence of diurnal rhythms on economic behavior.

2.4 Hypothesis Formulation

All of the preceding behavioral theories and empirical findings, when applied to our setting, lead us to hypothesize that the behavior of executives and analysts participating in quarterly conference calls will be subject to diurnal rhythms. Whether due to the depletion of their personal resources later in the day, and the resulting inability of call participants to regulate their disposition and thus the tone of their discourse, or due to human physiological factors associated with diurnal rhythms such as declining cortisol levels or a reduction in cognitive function, we expect to find differences between the tone of morning and afternoon call Q&A discussions. Specifically, we predict that the tone of management-analyst conversations will deteriorate, becoming more negative as the trading day wears on.

We note, of course, that our investigations can only document the hypothesized effect *on average*, across call participants. We cannot preclude the possibility that some call participants might begin their work days in a good mood, which Rothbard and Wilk (2011) show has an impact on how they perceive and respond to events later in the day. Similarly, some call participants might restore their glucose levels with food and/or refresh themselves with a walk, a vigorous physical workout, or take some form of rest from their intensely concentrated work prior to participating in afternoon calls. Any such behavior would likely lead to lower levels of afternoon

fatigue or otherwise mitigate the potential for greater negativity during calls that occur later in the day. Thus, any such noise in the relation between call tone and time-of-day that is induced by extraneous (i.e., non-diurnal) influences works against finding evidence in favor of our hypotheses. Notwithstanding this potential for noisy relations due to call participants' varying susceptibilities and/or mitigating behaviors, we present robust evidence of a time-of-day effect on our large sample of conference calls.

3. Sample, Call Transcripts, Tone Measurement, and Descriptive Statistics

3.1 Data Sources and Sample Determination

We obtain conference call transcripts, spanning the period of January 2001 to June 2007, from Thomson StreetEvents, a division of the Thomson Reuters news service and database vendor. We first restrict our sample to transcripts that StreetEvents identifies as earnings related, and to those for which we are able to extract a reliable call start time, city, and firm ticker information. We further restrict the sample to transcripts in which each of the management address, analyst question, and management answer portions of the call exceed 50 words, and to firms that are publicly-traded and headquartered in the United States. We focus on conference calls that we are able to confirm (by reference to Compustat) to be related to earnings announcements, which we define as falling into a window of (0, 2) days relative to the t=0 earnings announcement day, and for which we are able to extract location time zone. We require firms' annual financial data to be available from Compustat, their stock data to be available from CRSP and TAQ, and their analyst forecast and manager guidance data to be available from I/B/E/S. We exclude the conference calls of firm-quarters characterized as having a negative common book value of equity. In our calculations of residual tone (discussed in detail in Section 3.2), we make use of the entire sample of available call transcripts (i.e., spanning all time zones and call start times). For our primary time-of-day tests, however, we require some uniformity in call participants' presumed body clocks and thus we focus on calls that are initiated in Eastern or Central Time locations during the window of 08:00 to 15:59 Eastern Time.[2] The imposition of all of these constraints yields a sample of

[2] As explained in our discussion of the call tone descriptive statistics below, we limit the observations included in our primary regression analyses to calls that are initiated prior to the close of trading hours.

15,760 calls initiated by 1,730 distinct firms. In some robustness checks, we also include calls initiated in Pacific Time locations. Details related to the impact of each of the sample inclusion criteria on the final determination of the sample are summarized in Table 1.

3.2 Measuring Call Mood

As noted earlier, a major design strength of our study relative to the earlier literature that examines seasonal influences on summary measures of market activity (e.g., share prices) is that we can observe and track the behavior of the underlying agents in our setting. In light of this, and considering the particularly strong incentives (and thus pre-call preparation) involved for the firm's executives, it is interesting to consider whether both executives and analysts, as respective groups, are affected by diurnal influences. These investigations necessitate the separation of thousands of sample call transcripts into three component parts: i) management's presentation; ii) analyst questions; and iii) management's answers. The methodology that we use to arrive at this parsing of the text is described in detail in Appendix A.

We rely on the Loughran and McDonald (2011) ("L&M") finance-oriented dictionaries to calculate the *positivity* and *negativity* scores of each of the three components of the conference calls. Specifically, the scores are calculated as the number of incidences of words from each respective dictionary that are cited in the relevant text passage, scaled by the total number of words in the passage. Following the prior literature, we then take the difference between *Negativity* and *Positivity* in order to capture the net tone or mood of the call passage, and we refer to this measure as *NetNegativity*.[3]

Starting with these raw linguistic measures of the call passage's mood, we seek to separate call tone into that which is driven by economic news and fundamentals from that which is driven by the time-of-day effect or random noise. Following Huang, Teoh, and Zhang (2014), we begin with a first-stage regression designed to separate net negativity into two components, "economic tone" and "residual tone." Specifically, the first stage regression is as follows:

[3] Technically speaking, the prior literature takes the difference between optimism and pessimism (or positivity and negativity) and refers to this as net optimism (or net positivity). Because our principal hypothesis relates to deteriorating moods over the course of the day, for tractability in the text we have simply inverted the subtraction and defined mood in terms of net negativity, renaming the variable accordingly.

$$Tone = \alpha + \beta_1 SUE + \beta_2 Loss + \beta_3 FQ1GuideNews + \beta_4 PreCallAbnRet + \beta_5 Prior3MthRet + \beta_6 Size + \beta_7 MTB + \beta_8 SalesGrowth + \beta_9 FirmAge + \beta_{10} HighLev + \beta_{11} LowLiquid + \beta_{12} HiTec + \beta_{13} Consmr + \beta_{14} Finl + \beta_{15} Mfg + \beta_{16} Hlth + \varepsilon, \quad (1)$$

where the dependent variable, *Tone,* is alternatively the *NetNegativity* from the analyst questions, management answers, or combined Q&A portions of the call. We include the following explanatory variables to capture the economic news related to the earnings announcement: *SUE,* the earnings news for the quarter to which the earnings conference call relates (i.e., the standardized unexpected earnings relative to the most recent analysts' consensus estimate); *Loss*, an indicator variable that is set to one if the firm reports a loss for the quarter; *FQ1GuideNews*, the one-quarter ahead management earnings forecast surprise for firms issuing forecasts within a 3-day window starting on the earnings announcement day, and zero otherwise; *PreCallAbnRet*, the pre-call firm-specific abnormal stock returns on the day of the call, measured from the opening bell to the conference call start time, where "normal" returns are defined as the average returns to the firm's stock at the same time of day and on the same day of the week over the prior month (i.e., the average of the four prior weeks' observations); and *Prior3MthRet* are the buy-and-hold returns for the 3-month period ending on the last date of the fiscal quarter to which the conference call relates. Together these variables capture historical and forward-looking earnings-related news that has been released to the market prior to, and during, the period of the earnings announcement.

We also include additional explanatory variables related to the economics of the firm as follows: *Size,* measured as the natural log of the firm's market capitalization at the end of the quarter to which the call relates; *MTB,* or the market-to-book ratio, an expected growth measure; *SalesGrowth,* the percentage change in sales for the quarter to which the conference call relates relative to sales for the same fiscal quarter in the prior year; *FirmAge,* the natural log of one plus the number of years since the firm first appeared in CRSP; *HighLev*, an indicator variable set to 1 if the firm's leverage (calculated as total assets over the book value of shareholders' equity) exceeds 2; and *LowLiquid*, an indicator variable set to 1 if the firm's current ratio is below 1.0. The remaining variables are indicators that allow tone to vary by industry for each of the consumer goods (*Cnsmr*), manufacturing (*Mfg*), high-tech (*HiTec*), healthcare (*Hlth*), and financial (*Finl*) sectors, respectively. All variables are defined in greater detail in Appendix B.

Our first-stage regression thus includes explanatory variables that capture the current quarter's news (i.e., *SUE*, the loss indicator, and pre-call stock returns), forward-looking managerial guidance, firm size and life stage, industry norms, past and future growth prospects, as well as the financial health of the firm. The fitted values of *Tone* deriving from the parameter estimates from Equation (1) are referred to as "economics-driven tone," and we label these variables as *EconToneQuestion, EconToneAnswer* and *EconToneQ&A* for each of the analyst questions, management answers, and combined Q&A segments of the call, respectively. The residuals from these respective regressions (i.e., the ε's in Equation (1)) represent that portion of the call tone that is not explained by the economic news or other firm fundamentals. We refer to this as "residual tone" and label these variables *ResidToneQuestion, ResidToneAnswer* and *ResidToneQ&A*, respectively.

Results from the Equation (1) *Tone* regressions are presented in Panel A of Table 2.[4, 5] As shown, the earnings surprise (*SUE*), the earnings guidance surprise (*FQ1GuideNews*), past and future growth prospects, and prior stock returns are all negatively associated with *NetNegativity* for each portion of the call. In other words, as expected, positive (negative) earnings-related news is associated with positive (negative) discussion tone. Also consistent with expectations, the coefficients on the loss, high leverage, and low liquidity indicators are all positively associated with the net negative tone of discussions. Although we did not have directional priors for the relations between tone and firm size or firm age, we find that larger firms have more negatively toned questions and thus Q&A discussions, while older firms are associated with more positive questions but more negative answers, resulting in no net age-related effect on the combined Q&A. The fact that most of the candidate economic variables are significant and that all of those for which we have predictions take the expected signs, together with adjusted-R^2s in the range of 6.5% to 8.6% for these first-stage regressions (i.e., markedly higher than the 4% reported by Huang et

[4] Because the Equation (1) regressions do not rely upon time-of-day, we choose to include all available observations (i.e., including those calls initiated in Mountain and Pacific Time) in our estimates of economics-driven and residual tone in order to maximize statistical power and the precision of our coefficient estimates. However, all tests that rely upon these first-stage estimates are robust to using only EST and CST calls to estimate Equation (1).

[5] Unless otherwise noted, all of the continuous variables in this and other regressions reported in the paper are winsorized at the top and bottom one percentiles. In addition, we drop all observations that are influential in the determination of the tone dichotomization regressions, where influential observations are defined to be those for which the studentized residual exceeds 2, the Cook's D exceeds 1, or DFBETA exceeds 2, as recommended by Belsley, Kuh, and Welsch (1980).

al. (2014)), provide reassurance that the fitted variables from our first-stage regressions have good construct validity.

Panel B of Table 2 presents descriptive statistics for the raw positivity and negativity linguistic variables, as well as for the estimated measures of residual tone for each of the Q&A-related components of the call. Interestingly, the tone of the initial management presentation portion of the call is significantly more positive than that of the analyst questions or the combined Q&A (i.e., 1.72% positive words versus 1.28% positive words), while the percentage of negative words in the analysts' questions is significantly higher than the rate of negativity in managers' presentations and responses (i.e., 1.26% in the questions versus 0.85% and 0.76% in the presentation and answers, respectively). Thus, consciously or otherwise, executives are, on average, more positive and less negative than analysts in their discussions on the calls. Consistent with the estimation procedure discussed above, the *ResidTone* measures are mean zero, and they exhibit a good deal of variation.

3.3 Descriptive Statistics

Panel A of Table 3 presents descriptive statistics for the firm characteristics of our sample. As is evident, sample firms tend to have a significantly higher market-to-book ratio and to be substantially larger (measured by total assets, sales, or market capitalization), more profitable (based upon incidence of loss quarters), less likely to miss analyst estimates, and have a larger analyst following than the CRSP/Compustat/I/B/E/S universe. Because we focus on Eastern and Central time zone calls for our primary tests, this sample also naturally has disproportionately more (fewer) manufacturing (high-tech) firms than the database universe.

The remaining panels of Table 3 provide descriptive statistics related to conference call start times and their "stickiness" for 19,004 calls initiated in Eastern and Central time zones by 1,943 firms.[6] The top results in Panel B show that 41.7% of firms consistently hold their conference call at the same time of day, while 58.3% of firms vary the timing of their calls. In the lower set of results in Panel B, we find that 71.6% of firms "typically" hold their calls at the same

[6] Firms initiating calls outside of market hours are included in this analysis, while firms with only one call in our original dataset are necessarily excluded. Consequently, the number of firms and call observations underlying the "stickiness" descriptive statistics differs from that underlying our primary regression sample.

hour of the day, where "typically" is defined as 75% of the time.[7] Panel C shows that 55.2% of firms consistently hold their calls in the morning whereas only 14.6% of firms hold their calls exclusively in the afternoon. The remaining 30.2% of firms alternate between morning and afternoon call start times.

Panel D provides a transition matrix for firms that we characterize as having a high degree of stickiness (i.e., firms that hold their conference calls at precisely the same time with at least 75% frequency). As shown, 7.4% of "bad news" firm-quarters (i.e., those that either miss analyst estimates or report a loss) are associated with a change in the time of their conference call compared to the firm's typical call time, whereas 6.7% of "good news" firm-quarters involve a change in the time of their call relative to the prior quarter.[8] The difference between these two rates is not statistically significant, indicating that the good versus bad news flavor of the earnings news is not an important factor in "sticky" firms' decisions to change the time of their calls from one quarter to the next. This empirical observation is consistent with the evidence presented in Doyle and Magilke (2009) who conclude that there is a lack of evidence to support the notion that managers time their earnings announcements to hide bad news or to promote good news. Similarly, Panel E indicates insignificantly different propensities for firms that "meet or beat" versus those that "miss" analyst estimates to hold their calls in the afternoon.

Overall, the descriptive evidence presented in Panels B through E of Table 3 indicates that there is a high degree of "stickiness" in the timing of conference calls, and that the sign of the earnings news does not appear to affect this timing in a significant manner.

4. Empirical Results

4.1 Diurnal Variations in the Residual Tone of Conference Calls

We begin by investigating trends in the mean hourly net negativity that is not explained by economic news or firm fundamentals (i.e., the *residual tone* from the first-stage model depicted by Equation (1)). Figure 1 presents a graphical depiction of residual tone for question, answer,

[7] In untabulated results we also find that, 65.5% of firms "typically" hold their conference calls at exactly the same hour of the day, where "typically" is defined as 80% of time.
[8] Results are nearly identical when "bad news" is defined to include only firms that miss analyst estimates.

and combined Q&A portions of the calls that are held in Eastern and Central time zones, with calls being categorized according to the Eastern Time hour during which the call began. The lines through the graphs are fitted for calls initiated from 8:00 through 15:59 (i.e., to the closing of the market). As can be seen in Figure 1, the non-economics-driven, or residual, net negativity of the calls is increasing monotonically with every hour of the day, with the exception of a visually apparent but largely statistically insignificant improvement in mood (i.e., decline in residual net negativity) for calls starting between 14:00-14:59.[9] There is also evidence of a significant drop in *ResidToneAnswer* and *ResidToneQ&A* for calls held during the after-market hour of 16:00 to 16:59 (p=0.01), indicating that the stress relief from the close of the trading day results in a positive affect for call participants.[10] In general, the increasing slope of the fitted lines captures well the deteriorating mood of conference call tones over the course of the pre-market and trading periods of the day. Furthermore, a similar pattern is evident for both the question and answer (and therefore combined Q&A) portions of the calls, indicating that both analysts' and executives' moods are systematically varying with the time-of-day. This descriptive evidence provides a strong preliminary indication that there is a clear pattern of diurnal variations in the moods of the expert economic agents - both analysts and executives - participating in our large sample of calls.

We test these relations statistically by regressing the residual tone measures against the time of the call for all EST and CST calls initiated from 8:00 to 15:59. Specifically, we run the following regression:

$$\text{ResidTone} = \delta_0 + \delta_1 \text{EST\_Hour} + \varphi, \qquad (2)$$

where the dependent variable is alternatively *ResidToneQuestion, ResidToneAnswer* and *ResidToneQ&A*, and *EST_Hour* is the hour during which the call begins, measured in EST time.[11]

The results of the Equation (2) regressions are presented in Table 4. The positive coefficients on *EST_Hour* indicate that the net negativity of conference call communications that is not explained by economic news and other firm fundamentals is reliably increasing as the day wears

[9] Specifically, the decline in residual net negativity for calls beginning in the 14:00 hour is insignificant for *ResidToneQuestion* and *ResidToneQ&A*, and just barely significant for *ResidToneAnswer* (p=0.08).

[10] The removal of a stressor reduces the load being born by personal resource-constrained individuals, leading to an improvement in mood. The outward display of this more positive mood (as captured by language tone in our setting), is known in the psychology literature as a "positive affect."

[11] Our reported results are not affected when we alternatively regress *ResidTone* on the estimated start time of the Q&A session (i.e., rather than the start time of the call), where Q&A start times are estimated based upon word counts using the methodology proposed by Matsumoto et al. (2011).

on. These findings suggest that the non-economics-driven mood of call conversations is not just random noise, but is significantly explained by the time-of-day at which the call is held. Furthermore, the results are significant for each of analyst and management diction (and therefore also for the combined Q&A).[12] Thus, consistent with our hypothesis and with a large body of prior behavioral research in non-financial contexts, the analysts and executives participating in the more than 15,000 calls in our sample evince a significant susceptibility to diurnal rhythms in the performance of their work. Our findings thus provide novel evidence that even the behavior of highly trained expert economic agents acting in an important incentive-laden setting is influenced by the time-of-day. Furthermore, the unlikely presence of these effects in the context of such an important corporate event suggests that similar diurnal influences are likely to be at play in other economic decision-making and performance situations throughout business enterprises.

4.2 Diurnal Variations in Residual Tone: Robustness Checks

In this section, we present a number of robustness checks on our finding that the tone of conference calls is subject to deterioration as the trading day wears on.

West Coast Calls

Our key results presented above are based upon the available sample of EST and CST calls, a research design choice that was made in order to maximize the degree of body clock synchronicity of call participants across our various tests. There is, of course, no reason to presume that diurnal influences on human behavior are confined to the Eastern and Central parts of the U.S. Indeed, prior multi-locational Twitter studies have shown that similar mood patterns are observed across locations when time is measured in local hours (e.g., Mislove et al. (2010); and Golder and Macy (2011)). In our setting, we expect that the tone of PST calls may even be more negative than those of EST calls for the following reasons. First, most of the analysts on the calls are based on the East Coast, and hence at 10:00 a.m. PST, it is already 13:00 EST for most of the analysts,

[12] Prior studies provide evidence of a "Friday effect" in firms' news disclosure strategies, with bad news being more likely to be released on Fridays (e.g., Damodaran (1989)). In untabulated analyses we rerun each of our Equation (2) *ResidTone* against *EST_Hour* regressions alternatively including a Friday indicator variable and a Friday afternoon indicator variable. The Friday variables are never significant and they do not affect the coefficient on our *EST_Hour* variable of interest.

a time at which their mood is expected to have significantly deteriorated (relative to what it would have been on a 10:00 a.m. EST call, e.g.). Second, managers on the West Coast are keeping earlier local hours relative to their East Coast counterparts because they're working and interacting with stakeholders during EST-based market hours. Thus, by 10:00 a.m. PST, West Coast managers are likely to be further into their day (i.e., more fatigued, etc.), on average, than are East Coast managers at 10:00 a.m. EST.[13]

Our robustness test for diurnal influences on West Coast calls is presented in Table 5, where we include in the regressions all EST and PST calls initiated during the 8:00 to 15:59 EST window. For these tests, the time-of-day is captured using *Local_Hour* (i.e., time is measured in PST for West Coast calls and EST for East Coast calls). This relaxes the assumption embedded in our previous EST/CST tests (i.e., Table 4) that all call participants' body clocks are synchronous, allowing for variation across the two time zones. As shown, each of the three respective coefficients on *Local_Hour* is significant in these regressions, indicating, not surprisingly, that the non-economics-driven tone of call participants is increasingly negative for calls being hosted in both time zones. Of greater significance in Table 5 is the specification check afforded by the inclusion of *PST*, an indicator set to one for calls initiated in the Pacific Time zone (i.e., West Coast calls). The significant positive coefficient on the *PST* indicator in all three tone regressions indicates that the tone of West Coast calls is, on average, more negative than the tone of East Coast calls that are held at equivalent local times of day. We attribute this finding to the fact that PST call participants have more advanced body clocks due to the reasons specified earlier.

Omitted Variables – Analysis of Switching Firms

Our main results in Table 4 could be subject to the limitation that there may be something systematically different about firms initiating their calls later in the day relative to early callers, that our regressions haven't captured or adequately controlled for, and the correlation between this missing characteristic and *EST_Hour* may be inducing our results. In order to address this potential concern, we identify subsamples of firms that switch their call times and examine the change in

[13] The earlier schedule of PST managers is supported by the pattern of their conference calls, which tend to be held earlier in the day (measured in local time) relative to their East Coast counterparts' calls. For example, only 0.1% of EST calls are initiated before 8:00 a.m. whereas 7.7% of PST calls are initiated between 5:00-7:59 PST, while 18.1% of EST calls are initiated during the 15:00-17:59 (local time) period versus just 1% for PST calls.

the tone of their calls, a specification that implicitly holds constant all other firm-specific characteristics.

The first two subsamples are respectively defined to include firms that have switched from a morning call time in the previous quarter to an afternoon call time in the current quarter ("AM-PM switchers"), or vice versa ("PM-AM switchers"). Each switching firm call observation is then matched to a non-switching firm call on the basis of market capitalization, 2-digit SIC code, morning versus afternoon call initiation time in the previous quarter (i.e., before the switch), and the earnings fiscal year and quarter to which the call relates.[14] Table 6 reports the results of one-sided paired t-tests, Wilcoxon signed rank tests, and sign tests for differences between each of the switching firm samples and their respective matched control group. As shown, there are significant differences in the change in Q&A tone for switching firms relative to non-switching firms across all three differences tests. Specifically, the first row of Panel A indicates that the change in the tone of Q&As that is not explained by economic variables (i.e., *delta_ResidToneQ&A*) is significantly *more negative* for firms switching from morning to afternoon calls than for non-switching matched firms as the top row (left two columns) of Panel A indicates that morning-to-afternoon switchers experienced a mean 0.006 increase in net negativity, whereas the matched control firms had a 0.058 decrease in net negativity, and the difference between the two is significant. Similarly, the results in the top row of Panel B indicate that *delta_ResidToneQ&A* for firms that switch from an afternoon to a morning call time is significantly *less negative* than the change in Q&A tone for the non-switching control sample. Afternoon-to-morning switchers experienced a 0.096 negativity decrease, relatively to a substantially smaller 0.009 decrease for control firms, with the difference between the two being statistically significant. Although the sample sizes for these tests are relatively small, we find that many of the matched pair differences in the changes in tone for the separate question and answer subcomponents of the calls are also significant.

The preceding tests consider only morning-to-afternoon and afternoon-to-morning switchers. However, there is a somewhat larger sample of firms that switch their call time *within* the day ("time switchers"), albeit not necessarily from morning to afternoon or vice versa. The results of

[14] More specifically, we require that the market capitalization of each match firm be within $200 million of its peer switching firm. In untabled tests we find the paired test for differences in firm size between control and switching samples to be insignificantly different from zero.

regressions of the change in residual tone for these firms on the change in the start time of the call (*delta_Hour*) are presented in Panel C of Table 6. The regressions include an indicator variable, *EarlierCall*, which is set to one if the firm chooses an earlier call time, as well as an *EarlierCallXdelta_Hour* interaction term that allows for an asymmetric response in the change in tone for firms switching to an earlier versus a later time-of-day. As shown, the change in residual tone for all three components of the Q&A is significantly positively associated with *delta_Hour*, indicating that tone becomes reliably more (less) negative when firms switch to a later (earlier) call time.

In summary, despite making use of more restricted and thus relatively small samples, the combined evidence from the tests reported in Table 6 offers substantial support for the notion that changes to later (earlier) call times lead to deteriorations (improvements) in the mood of conference call conversations between executives and their firm's analysts. We conclude from these differences tests that our finding of a relation between the time-of-day and non-economics-driven call negativity is not due to firm-specific variables having been omitted from the regressions reported in Table 4.

Endogeneity

For various institutional reasons it is unlikely to be the case that firms with negative economic news that is not adequately controlled for in our first-stage tone regression (i.e., Equation (1) that parses economic tone from residual tone) deliberately select afternoon call time slots. First, as established earlier, call start times are highly "sticky", and thus they're predetermined (by default) independently of the news to be reported. Second, even for non-sticky firms, call start times tend to be determined well in advance, prior to the time that results for the quarter have become known to management.

Notwithstanding this, we address the potential for endogeneity between the firm's choice of call time and the tone of the conversations that ensues in two alternative ways. In the first robustness check, we introduce the inverse Mills ratio (*Lambda*) from a parsimonious probit regression of the decision to initiate an afternoon call into the Equation (2) tone regressions. The first-stage model includes all significant candidate variables for explaining the afternoon call choice. The first column of Table 7A presents the results of an exploratory probit regression

modeling this decision.[15] As shown, and consistent with the descriptive evidence presented earlier that call start times are "sticky" and that call start times are not driven by the flavor of the quarterly earnings news, the firm's experience of having held an afternoon call in the prior quarter, as captured by the *Lag_Afternoon* indicator, is by far the most important determinant of the likelihood that the firm will host an afternoon call in the current quarter. Once *Lag_Afternoon* is included in the decision model, the magnitude of the earnings surprise (*absSUE*), an indicator set to one for firms reporting "bad news" (*BadNews*), the number of analysts following the firm (*logAnalyst*), and a variable capturing the firm's dependence on equity financing (*EquiDepend*) are all insignificant. Only *InvestIntense*, a variable capturing the firm's investment intensity that is due to Rajan and Zingales (1998), and *HiTec*, an indicator set to one if the firm is in a high-tech industry, remain significant with *Lag_Afternoon.*

The second column of Panel A of Table 7 presents the results of the first-stage probit regression, including only the aforementioned variables that are significant in explaining the afternoon call time decision, that we use to estimate the *Lambda* to be used in the second stage model. The pseudo-R^2 of 46% suggests that our decision model does a good job of explaining the afternoon call time choice. Most importantly, the Equation (2) residual tone regression results in Panel B of Table 7 indicate that our key inferences related to a diurnal effect on call participants' moods are robust to controlling for *Lambda* as *EST_Hour* remains significant in each residual tone regression.

We undertake a second robustness check following the methodology proposed by Lennox, Francis, and Wang (2012) who suggest that it may be better in some cases to avoid a two-stage approach, as described above, due to the potential for mis-specification of the first-stage selection model. Specifically, Lennox et al. (2012) recommend including the significant determinants of the potentially endogenous variable (i.e., afternoon call time choice in our case) directly in the would-be second-stage regression (i.e., the residual tone regressions in our setting) rather than to include the estimated *Lambda* because the latter fitted value may be subject to undesirable measurement error. Accordingly, in our second robustness test we augment the Equation (2) residual tone regressions with the variables that were significant in the afternoon call choice model (i.e., *Lag_Afternoon*, *HiTec*, and *InvestIntense*). The results from this test are presented in Panel C of Table 7. As shown, the significant positive relations between the time-of-day at which the call

[15] All variables are defined in greater detail in Appendix B.

is held (*EST_Hour*) and the net negative tone of the call all still hold for the analyst question, management answer, and combined Q&A portions of the conference call discussions, even after these control variables have been included.

In summary, we conclude from these two tests that our key finding of a significant diurnal effect on analyst and executive behavior remains robust to controlling for the potential for endogeneity in the call start time decision.

Summary of Robustness Tests

Our robustness tests have addressed the potential effects of correlated omitted variables and firm self-selection into afternoon call timeslots on our primary tests related to diurnal influences impacting conference call discussion tone. Combined analyses of calls initiated in Eastern and Pacific Times establish that the influence of diurnal rhythms is exacerbated for West Coast calls, a finding that we attribute to the more advanced body clocks of these calls' participants. All of these robustness tests support our conclusion that there are strong and reliable diurnal patterns in the behavior of both managers and analysts during earnings conference call discussions. Specifically, the tone of manager-analyst communications becomes more negative as the day wears on, consistent with the predictions of personal resources theory and with the effects of circadian rhythms on human behavior.

4.3. Impact on Share Prices

We now consider an important consequence of our key finding that conference call participants' moods are subject to diurnal rhythms by investigating whether there is a differential investor response associated with the tone of morning versus afternoon calls. In an efficient market, the stock price should not respond to the portion of call tone that is not driven by economic news or firm fundamentals. In particular, "excess" afternoon net negativity that arises due to the influence of diurnal rhythms on human moods should not be priced. And yet, doubts about the extent of market efficiency linger.

In order to investigate this issue, we first use a regression residuals approach to obtain an estimate of the call tone that is determined by the time-of-day at which the call conversations take place. Specifically, we take the residuals (i.e., ε's) from the Q&A regression Equation (1), which

represent that portion of the net negative tone of conference call Q&A communications that is *not* explained by economic news or firm fundamentals, and regress these residuals on *EST_Hour* as follows:[16]

$$\varepsilon = \gamma_0 + \gamma_0 EST\_Hour + \omega. \qquad (3)$$

The fitted values from this regression, which we label *DiurnalToneQ&A*, provide a measure of the conference call tone that is attributable to the time-of-day at which the call is initiated, and that is orthogonal to the economic news and firm fundamentals included in the previous first-stage regression (i.e., Equation (1)). The residual from Equation (3), ω, is the unexplained call tone (i.e., tone that is neither related to economic or firm fundamentals, nor to the time-of-day). Together, the Equations (1) and (3) regressions separate the net negativity of conference call Q&A conversations into three components: economics-driven tone that is explained by economic news and firm fundamentals (*EconToneQ&A*), which is measured by the fitted values from Equation (1); *DiurnalToneQ&A*, which is the non-economic tone that is attributable to the time-of-day effect on call mood, as measured by the fitted values from Equation (3); and unexplained net negativity (*UnexplainedToneQ&A*), which is the ω term from Equation (3).

We then examine the market's pricing of these three components of tone using the following stock returns regression:

$$AbnRet = \theta_0 + \theta_1 EconToneQ\&A + \theta_2 DiurnalToneQ\&A + \theta_3 UnexplainedToneQ\&A + \vartheta \qquad (4)$$

where the dependent variable, *AbnRet*, is the abnormal return measured over various intraday and longer post-call intervals as defined below, and all other variables are as defined above and in greater detail in Appendix B.

Our first abnormal returns accumulation period begins with the estimated start time of the Q&A portion of the call. Following the methodology outlined by Matsumoto et al. (2011), we assume that 160 words are spoken per minute during the presentation portion of the call, that the presentation begins approximately 116 seconds after the stated call start time, and that the Q&A

[16] Our reported results are robust to alternatively regressing the ε's on the start time of the Q&A session estimated using the methodology proposed by Matsumoto et al. (2011) rather than the start time of the call. Influential observations, defined to be those for which the studentized residual exceeds 2, the Cook's D exceeds 1, or DFBETA exceeds 2, are deleted from the determination of this regression.

begins 28 seconds after the end of the management presentation. The start time of the Q&A is therefore estimated to be as follows:

$$call\ start\ time + \left(\frac{\#\ of\ words\ in\ management\ presentation}{160}\right) minutes + 144\ seconds$$

We compute the 5-hour abnormal returns measured from this estimated start time to the end of the 5th hour of trading (i.e., a period that may extend into the next day's trading). Specifically, the abnormal returns are calculated as the difference between the firm's returns during the 5-hour window beginning with the Q&A discussion minus the average returns during the corresponding 5-hour window on the same day of the week over the previous month (i.e., the average of four weekly observations).

The results from this abnormal returns regression are presented in the first column of Table 8. As shown, abnormal returns from this intraday window are negatively associated with each of *EconToneQ&A*, *UnexplainedToneQ&A*, and *DiurnalToneQ&A*. This finding of an association between linguistic tone and stock returns is consistent with the prior literature that has reported written or spoken linguistic tone to be contemporaneously informative and/or to have predictive content for stock prices in numerous other managerial communications or conference call settings (e.g., Davis, Piger, and Sedor (2012); Price, Doran, Peterson, and Bliss (2012); Mayew and Venkatachalam (2012); Demers and Vega (2014); Baginski, Demers, Wang, and Yu (2015); and Mayew, Sethuraman, and Venkatachalam (2015), amongst others). The finding that both economically-justified tone and unexplained residual tone are priced in a short event window is consistent with the prior findings of Huang et al. (2014). Most importantly in these results, however, is that 5-hour abnormal returns are negatively associated with the estimated non-value-relevant tone that is driven by diurnal influences, *DiurnalToneQ&A*. This new finding suggests that investors don't initially distinguish between the time-of-day-induced, non-economic aspect of conference call negativity and the portion of tone that is conveying economically-relevant news.

In the remaining columns of Table 8 we present the associations between the three measures of call tone and abnormal returns, defined here relative to firms with similar size and market-to-book ratio, for various periods. Notably, we find that *EconToneQ&A* and *UnexplainedToneQ&A* are subject to some post-call drift during the 5-trading-day period subsequent to the close of the 5-hour intraday call window, as indicated by the negative coefficient on these variables. This finding that is consistent with the notion that "soft" textual (or verbal)

content is more difficult to process quickly than "hard" earnings news, evidence of which has previously been provided by Engelberg (2008), Price et al. (2012), and Demers and Vega (2014). More importantly, however, the results for the [16, 30] day period show a positive coefficient on the *DiurnalToneQ&A* variable, indicating a reversal of the diurnal tone that was previously priced during the 5-hour returns interval. The combined findings indicate that the "excessive" call negativity that is driven by the influences of the time-of-day on human behavior doesn't have a sustained, long-term effect on share prices. Consistent with this, the final column of Table 8 shows that *DiurnalToneQ&A* has a zero net effect upon returns over the longer term, as it is not significantly associated with 30-day returns beginning with, and including, the 5-hour intraday event period. [17] In summary, this market-based test supports the notion that executives and analysts are subject to diurnal influences, exhibiting excessive later day conversational negativity that is unrelated to the firm's economics, which initially impacts share prices, but over a longer term is discounted by investors. Thus, in addition to corroborating our main finding regarding diurnal rhythms impacting executives' and analysts' behavior in an important corporate communications setting, these returns analyses also reveal that there are short-term economic consequences in the form of temporary stock mispricings associated with the time of day at which the calls are held.

5. Summary and Conclusion

A significant body of psychological and physiological research has documented the impact of diurnal rhythms on human moods and performance. Due to limited personal resources and/or the multi-faceted effects of circadian rhythms, the time of day influences human emotions, biology, cognitive function, and other aspects of behavior and performance. While diurnal rhythms have been shown to influence behavior in casual settings such as Twitter communications, as well as decision-making and compliance with professional standards in contexts such as the judiciary and medicine, to the best of our knowledge no prior study has investigated the influence

[17] Our key findings are unaffected by the inclusion of *ResidTonePresent*, the residual tone from the management presentation portion of the call (i.e., the residual from Equation (1) regressions using managerial presentation tone as the dependent variable), in the returns regressions reported in Table 8 in order to control for any non-economics-driven tone emitted during management's presentation. Specifically, *DiurnalToneQ&A* remains significant with a negative (positive) coefficient in the 5-hour ([16, 30] trading day) regression, and is insignificant in the [5-hour, 30 trading day] window.

of diurnal rhythms on the behavior of expert economic agents in a real and important corporate setting.

We conduct a large sample investigation into this issue by applying linguistic algorithms to over 15,000 time-stamped actual earnings conference call transcripts and find that the time-of-day influences the tone of corporate communications between executives and investors. Our study thereby presents novel and robust evidence of the influence of diurnal rhythms on expert economic agents' behavior. Specifically, we show that the tone of non-economics-driven conference call Q&A discussions exhibits significant diurnal patterns, becoming more negative as the day wears on. Furthermore, the diction of both executives and analysts on the calls is affected by these diurnal influences. Our results are robust to controls for potential endogeneity in the self-selection of afternoon callers and to the omission of firm-specific variables that may be correlated with the time-of-day. Tests using a bi-coastal sample establish that diurnal influences are exacerbated for West Coast calls, presumably due to the more advanced body clocks of these calls' participants when measured in local time. Finally, abnormal stock returns tests confirm that there is excess negative conversational tone later in the day that the market ultimately assesses to be value-irrelevant, but only after a period of temporary mispricing.

In summary, we contribute to the managerial, behavioral economics, financial linguistics, and corporate communications literatures by presenting novel and surprising evidence that sophisticated economic agents acting in real and highly incentivized settings are influenced by diurnal rhythms in the performance of their professional duties. In addition, our evidence suggests that there are potentially important economic consequences associated with this phenomenon. Aside from the measurable effects in terms of temporary stock mispricings, excess negativity on the calls may also affect executives' relations with their analysts and/or their reputations with other firm constituents who listen to (or later read the transcript of) the calls. Furthermore, when considered together with the prior literature related to limited personal resources and the effect of circadian rhythms on human emotions, cognitive function, and other dimensions of behavior and performance, our evidence in the context of measurable attributes of conference calls and their consequences is suggestive of a potentially much broader phenomenon of diurnal rhythms impacting many other communications throughout hierarchical levels and across many decision-

making and performance situations within business enterprises. Finally, on a practical level, our findings alert executives to the advantage of conducting early day communications with investors.

Appendix A

Methodology Used to Parse Conference Call Transcripts

The conference call transcripts are furnished to us by Thomson StreetEvents, a division of the Thomson Reuters news service and database vendor, in .html format. The files include time-stamps and dates, firm identifiers and other file formatting detail, as well as the verbatim transcripts of the call conversations (i.e., including operator instructions and other opening/closing remarks). Our empirical analyses require that we develop algorithms to separate the thousands of call transcripts into three separate components of speech: i) management's opening address; ii) analysts' questions; and iii) management's answers. The methodology that we use to effect this is as described below.

First, we need to separate the conversational elements of the call from the firm identifiers, list of call participants, and other formatting detail included in each file. To do so, we include only the text body between "<Body>" and "</Body>", the markers for the start and end of the call contents, respectively. Second, to identify the beginning of the conference call content, we search the file for "Presentation---" or "Transcript---". If there is no such "Presentation---" or "Transcript---" indicator, then we allow the first time the operator speaks to mark the introduction of the management presentation portion of the call.

Within each call transcript, and at every change in speaker, the new speaker is normally identified by their proper name or as the operator/moderator before they speak.[18] It is typically possible to cleanly separate the operator's introductory remarks from the beginning of the management presentation portion of the call by denoting the management address to be the first speech that occurs on the call after the operator's opening remarks and instructions to participants. Similarly, there is commonly an identifiable separator between management's address and the Q&A portion of the call, which we're able to locate by searching for "Questions and Answers". If such an indicator does not exist, then because the operator speaks at the conclusion of the management address in order to open the Q&A session, we take the first occurrence of "Operator" (or another operator-related alias) as speaker after the first 500 words of the management address to mark the introduction of the Q&A session. Naturally, we exclude the operator/moderator's

[18] Numerous aliases were found to be used to identify the operator on the call, including the following: operator, moderator, female speaker, male speaker, and editor.

speech that opens and closes the conference calls or that prompts analysts for questions from our linguistic analyses and word counts. Similarly, the list of call participants at the start of the transcripts, and all of the other labels and speaker names inserted into the transcripts by Thomson Reuters are excluded from text files that are processed through the linguistic algorithms.

Separating the text of the Q&A into analyst questions and managerial answers is a more difficult undertaking. Our first step is to identify the proper names of all of the executive speakers on the call so that we can classify all of the speech attributed to these individuals to the "answers" portion of the Q&A. If the call transcript lists the corporate participants separately from analyst participants, then we use this list to identify the firm's executives. If there is no such list provided in the transcript, then we create a list of executive participants using the names collected from the management presentation session through a two-step procedure, as follows. First, we collect each of the names that prefaces an element of speech in the management presentation session. This will not produce a complete list of corporate participants, however, because not all executives on the call speak during the initial address. As a complement to this list, therefore, we scan the beginning of the first executive's speech for proper names and compare this to the combined list of all call participants, where such a list is available, and identify any matched names to be corporate executives (i.e., this procedure recognizes that at the start of the management address, the speaking executive will typically introduce the other executives who are on the call with him/her). In addition to this list of the proper names of corporate executives, we add speakers identified as "unidentified company ---" and "unidentified corporate ---" to the list of corporate participants. All speech attributed to any of these parties is considered to be part of the "answers" portion of the Q&A. Any speech that is not attributed to corporate participants using this algorithm, and that is not labeled as being from the operator/moderator, is likely to come from the analysts. However, in order to assign this speech to the analyst question portion of the call, we require that it either be attributed to a particular person (i.e., be prefaced by a proper name) or to "Unidentified audience ---". There are elements of some calls' transcripts, however, that we cannot reliably identify as either managers' or analysts' speech. For example, a portion of speech may be prefaced by "unidentified speaker" or "unidentified participant" rather than by either "operator" or "unidentified corporate" or a proper name that would enable us to identify the speaker as a member

of the management team versus an analyst. Given the potential for noise or error in attributing the speech in these cases to one party or another, we drop these observations. [19]

[19] In untabulated specification checks, we find that all of our main results are unaffected by including these observations in the analyses while excluding the unidentified portions of speech from the calculation of the managerial and analyst tone variables.

Appendix B

Variable Definitions

Variable	Definition
NetNegativity	*Positivity* minus *Negativity*. *Positivity* equals Loughran and McDonald (2011) positivity score/the total number of words in the relevant portion of the call*100, and *Negativity* equals Loughran and McDonald (2011) negativity score/the total number of words in the relevant portion of the call*100. We calculate this variable for analyst questions, management answers, the Q&A combined, and the management presentation segments of the call, and we refer to these variables as *NetNegativityQuestion*, *NetNegativityAnswer*, *NetNegativityQ&A*, and *NetNegativityPresent*, respectively.
EST_Hour	The hour of the call's initiation, measured in Eastern Standard Time.
SUE	Standardized unexpected earnings for the quarter to which the conference call relates. Unexpected earnings are calculated as reported EPS minus the analyst consensus one day prior to the earnings announcement. We standardize the unexpected earnings by dividing it by the standard deviation of realized EPS in the prior 20 quarters. A minimum of three (and maximum of 20) prior quarterly EPS are required (allowed) for this variable to be calculated.
Loss	An indicator variable set equal to one if the firm reports a loss for the quarter to which the conference call relates.
FQ1GuidNews	Standardized guidance news for the next fiscal quarter if the guidance is issued in [-2, 0] day around the conference call, and 0 otherwise. Guidance news is calculated as EPS guidance minus prior prevailing analyst consensus EPS forecast, and we standardized it by the standard deviation of realized EPS in the prior 20 quarters. A minimum of three (and maximum of 20) prior quarterly EPS are required for this standard deviation to be calculated.
PreCallAbnRet	Pre-call firm-specific abnormal returns on the day of the call, measured from the opening bell to the call start time, and where "normal" returns are defined as the average returns to the firm's stock at the same time of day and on the same day of the week over the prior month (i.e., the average of the four prior weeks' observations).
Prior3MthRet	Buy and hold monthly returns for 3 months as of the end of the fiscal quarter to which the conference call relates.
Size	Log of the market capitalization of the firm at the end of quarter to which the conference call relates.
MTB	Market to book ratio at the end of the quarter to which the conference call relates.
SaleGrowth	Percentage change in sales for the quarter to which the conference call relates relative to sales for the same fiscal quarter in the prior year.
FirmAge	Log of 1 plus the number of years since the firm first appears in CRSP.
HighLev	An indicator variable set to 1 if the firm's leverage (total assets over the book value of shareholders' equity) at the end of the quarter to which the conference call relates exceeds 2, and zero otherwise.
LowLiquid	An indicator variable set to 1 if the firm's current ratio at the end of the quarter to which the conference call relates is below 1.0, and zero otherwise.
Cnsmr	Fama French consumer industry indicator: Consumer Durables, Non-Durables, Wholesale, Retail, and Some Services (Laundries, Repair Shops).

Mfg	Fama French manufacturer industry indicator: Manufacturing, Energy, and Utilities.
HiTec	Fama French high-tech industry indicator: Business Equipment, Telephone and Television Transmission.
Hlth	Fama French health industry indicator: Healthcare, Medical Equipment, and Drugs.
Finl	Financial industry with 4-digit SIC code between 6000 and 6999.
EconTone	*EconToneQuestion, EconToneAnswer, EconToneQ&A,* and *EconTonePresent* for each of the analyst question, management answer, combined Q&A, and the management presentation segments of the call, respectively, represent the portion of the call tone that is explained by the economic news or other firm fundamentals.
ResidTone	*ResidToneQuestion, ResidToneAnswer, ResidToneQ&A,* and *ResidTonePresent,* for each of the analyst question, management answer, combined Q&A, and the management presentation segments of the call, respectively, represent the portion of the call tone that is not explained by the economic news or other firm fundamentals.
PST	An indicator variable set to 1 for calls initiated in the Pacific Time zone, and zero otherwise.
Local_Hour	The hour, stated in local time, at which the conference call is initiated.
delta_Hour	The change in the start time of the call, measured in hours.
EarlierCall	An indicator variable set to 1 when the firm chooses an earlier conference call time compared to the previous quarter, and 0 otherwise.
Afternoon	An indicator variable set equal to 1 for conference calls initiated at, or after, 12:00 p.m. EST, and zero otherwise.
Lag_Afternoon	An indicator variable set equal to 1 when the firm's prior conference call was held in the afternoon, and zero otherwise.
absSUE	The absolute value of *SUE.*
BadNews	An indicator variable set equal to 1 when unexpected earnings are negative for the quarter to which the conference call relates, and zero otherwise.
logAnalyst	The natural log of one plus the number of analysts following the firm.
FQ4	An indicator variable set equal to 1 if the conference call relates to the fourth fiscal quarter, and zero otherwise.
EquiDepend	The sum of the net amount of equity issuances in the prior three fiscal years divided by the sum of capital expenditures over the prior three fiscal years. The net amount of equity issuances is calculated as Compustat SSTK minus PRSTKC.
InvestIntense	The sum of capital expenditures over the prior three years divided by the sum of property, plant and equipment over the prior three years.
DiurnalToneQ&A	A measure of the conference call tone that is attributable to the time-of-day at which the call is initiated.
UnexplainedToneQ&A	Conference call tone that is neither explained by economic or firm fundamentals, nor by the time-of-day.
5 Hour Event AbnRet	The difference between the firm's returns during the 5-hour conference call window minus the average returns during the corresponding window on the same day of the week over the previous month (i.e., the average of four weekly observations). The 5-hour event window begins at the start time of the Q&A session, which is approximated following the methodology and parameters suggested by Matsumoto et al. (2011), and may roll into the subsequent trading day (i.e., in the case of later day calls).

Post Call AbnRet	Size and book-to-market adjusted abnormal returns for the [1, 5], [6, 15], or [16, 30] trading days subsequent to *Day 0*, where *Day 0* is the day on which the 5-hour abnormal returns event window is closed.
[5 Hour, 30TD] AbnRet	Cumulative abnormal return from the start time of the Q&A through to, and including, 30 trading days subsequent to *Day 0* as defined above.

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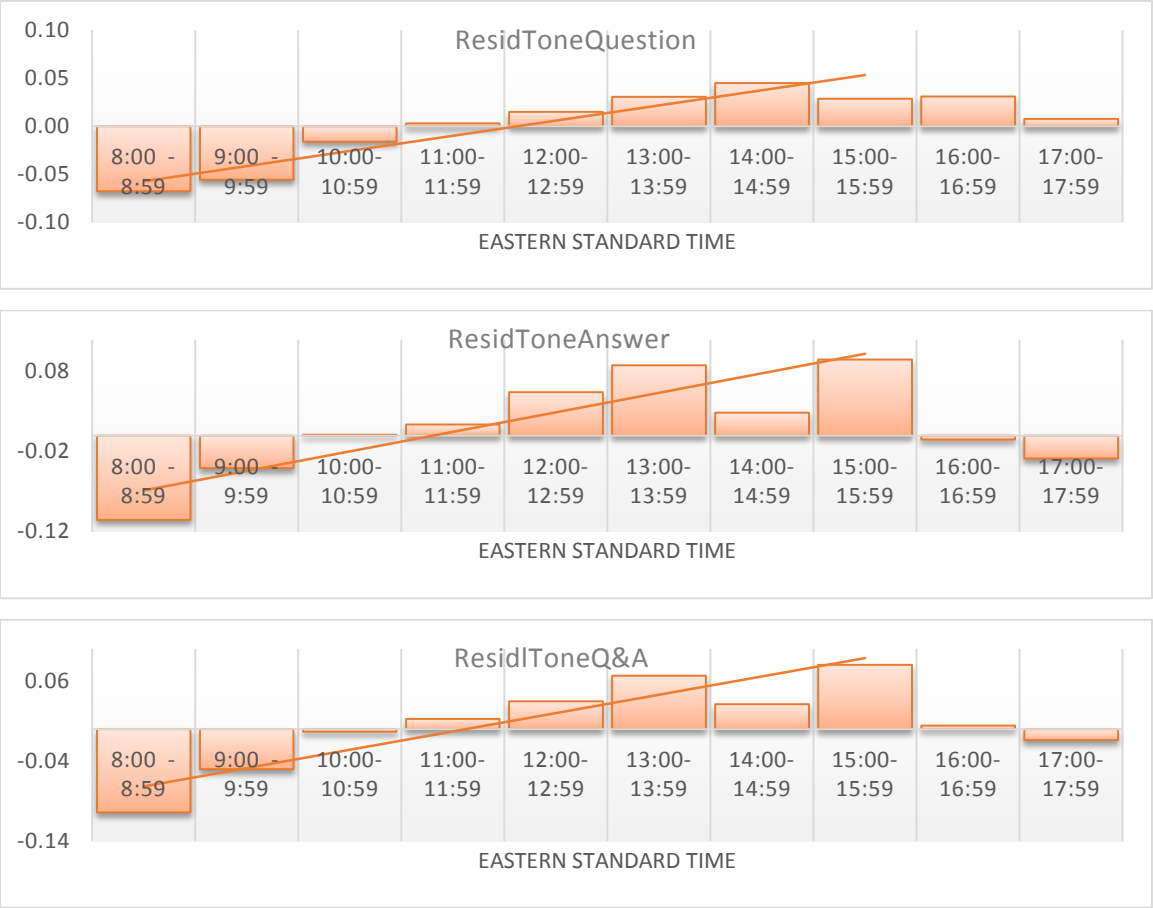
Figure 1: Residual Tone for Question, Answer, and Combined Q&A



Note:

This figure presents a graphical depiction of residual tone for the question, answer, and combined Q&A portions of the calls that are held in Eastern and Central time zones, with calls being categorized according to the Eastern Time hour during which the call began. The lines through the graphs are fitted for calls initiated from 8:00 through 15:59 (i.e., to the closing of the market).

Table 1: Sample Determination

	No. Obs.	**No. Firms**
Transcripts provided by Thomson StreetEvents from Jan2001 to Jun2007	96,892	
Transcripts that StreetEvents identifies as earnings-related, and for which we are able to extract a reliable call start time and firm ticker	75,639	5,439
Exclude calls for which separation of managers' answers from analysts' questions cannot be reliably performed due to the structure of the transcript files	64,602	5,361
Word count exceeds 50 words for each of the management presentation, management answers, and analyst questions elements of the call	61,669	5,258
Firms that are publicly-traded and headquartered in the United States[1]	61,531	5,247
Earnings release conference calls held within [0,2] trading days around earnings announcements[2]	48,195	4,595
Locations of conference calls can be identified as being held in U.S. cities[3]	38,280	3,411
Regression variables calculated using Compustat, I/B/E/S, CRSP, TAQ are non-missing	28,722	2807
Firm quarters with non-negative book value of common equity	**28,098**	**2,771**
Delete influential observations in the first-stage regression separating net negativity into economic tone and residual tone	**26,719**	**2,744**
Calls in Eastern and Central time zone	**19,004**	**1,943**
Calls with start times between 8:00 to 15:59 Eastern Time	**15,760**	**1,730**

Note:

1. Merged with Compustat NA database based on ticker symbol and/or firm name.

2. We utilize information about transcript types provided by Thomson StreetEvent (e.g., earnings release conference call, conference presentation, etc.). Further, we retain conference calls that we are able to confirm to be related to earnings announcements by requiring the date of the call to be in the range of [0, 2] days of an earnings announcement date (RDQ) reported in Compustat.

3. The transcripts provided by Thomson StreetEvents include the start time of the conference call stated in GMT format, which we extract together with the name of the city where the call is initiated (the state and the country of call origination are not provided). We then use the sashelp.zipcode file, which provides detailed location and time zone information for U.S. cities, to translate the GMT start times into Eastern Time for consistency with the market hours being investigated in our study. For those cases where multiple cities of the same name confound the use of the SAS zip code function, we refer to the Compustat NA company file to identify the location of the firm's headquarter (CITY) and principal location (STATE). We use these Compustat variables together with the assumption that the call is originated in the firm's headquarter or principal location to infer the time zone in which the call was originated. We refer to official daylight savings start and end dates in each of GMT and Eastern Time zones in order to ensure that all GMT times extracted from the call transcripts have been correctly restated into Eastern Time.

Table 2: Linguistic Measures

Panel A: First-Stage Regressions Dichotomizing Tone into *EconTone* and *ResidTone*

	NetNegativityQuestion		*NetNegativityAnswer*		*NetNegativityQ&A*	
SUE	-0.142	***	-0.086	***	-0.099	***
	(-16.88)		(-12.98)		(-16.98)	
Loss	0.112	***	0.072	***	0.080	***
	(10.57)		(8.61)		(10.77)	
FQ1GuideNews	-0.142	***	-0.032	***	-0.061	***
	(-9.38)		(-2.71)		(-5.78)	
PreCallAbnRet	-1.492	***	-0.546	***	-0.819	***
	(-11.69)		(-5.45)		(-9.20)	
Prior3MthRet	-0.262	***	-0.135	***	-0.171	***
	(-13.45)		(-8.82)		(-12.55)	
Size	0.034	***	-0.002		0.008	***
	(11.55)		(-0.82)		(3.73)	
MTB	-0.004	***	-0.007	***	-0.006	***
	(-2.63)		(-6.64)		(-6.61)	
SalesGrowth	-0.015		0.001		-0.006	
	(-1.21)		(0.12)		(-0.68)	
FirmAge	-0.012	**	0.009	**	0.003	
	(-2.17)		(2.05)		(0.80)	
HighLev	0.036	***	0.020	***	0.023	***
	(3.95)		(2.79)		(3.71)	
LowLiquid	0.016		0.068	***	0.049	***
	(1.17)		(6.37)		(5.15)	
Intercept	-0.293	***	-0.539	***	-0.455	***
	(-12.53)		(-29.30)		(-27.87)	
Industry Sector Dummies	Yes		Yes		Yes	
N	26,719		26,719		26,719	
R-square	0.0651		0.0702		0.0862	

Table 2: Linguistic Measures (Continued)

Panel B: Tone measure statistics

Tone	N	Mean	Std Dev	25th Pctl	Median	75th Pctl
Negative words in analyst questions	26,719	16.39	9.25	10.00	15.00	22.00
Negative words in manager answers	26,719	24.06	14.43	13.00	22.00	32.00
Negative words in Q&A combined	26,719	40.44	21.37	25.00	38.00	53.00
Negative words in manager presentation	26,719	25.40	15.54	14.00	22.00	33.00
Positive words in analyst questions	26,719	16.25	9.03	9.00	15.00	22.00
Positive words in manager answers	26,719	39.94	22.04	23.00	37.00	53.00
Positive words in Q&A combined	26,719	56.20	28.01	35.00	53.00	74.00
Positive words in manager presentation	26,719	52.83	28.67	32.00	48.00	68.00
%Negative words in analyst questions	26,719	1.26	0.41	0.98	1.24	1.51
%Negative words in manager answers	26,719	0.76	0.28	0.56	0.73	0.93
%Negative words in Q&A combined	26,719	0.91	0.26	0.73	0.88	1.07
%Negative words in manager presentation	26,719	0.85	0.40	0.56	0.78	1.06
%Positive words in analyst questions	26,719	1.29	0.51	0.94	1.24	1.59
%Positive words in manager answers	26,719	1.28	0.42	0.98	1.24	1.54
%Positive words in Q&A combined	26,719	1.28	0.37	1.02	1.25	1.51
%Positive words in manager presentation	26,719	1.72	0.58	1.31	1.68	2.08
Residual net negativity in analyst questions	26,719	0.00	0.62	-0.39	0.04	0.44
Residual net negativity in manager answers	26,719	0.00	0.49	-0.32	0.03	0.35
Residual net negativity in Q&A combined	26,719	0.00	0.43	-0.28	0.03	0.31

Note:

Panel A of Table 2 presents the results of a first-stage regression to dichotomize tone into two distinct components: the net negativity that is explained by economic news related to the earnings announcement and firm fundamentals; and the "residual" tone, which is the remaining tone that is not explained by economic variables. T-statistics are shown in parentheses. *, **, *** indicate coefficients that are significantly different from zero at the 0.10, 0.05, and 0.01 level, respectively, using a two-tailed test. Panel B shows the descriptive statistics of tone measures. All variables are defined in greater detail in Appendix B.

Table 3: Descriptive Statistics

Panel A: Sample Characteristics

Sample	N	Mean	Std Dev	25th Pctl	Median	75th Pctl
Total Assets	15,760	10,047.39	26,985.36	558.39	1,798.49	5,943.44
Sales	15,760	1,432.56	4,270.37	101.95	289.35	1,040.92
Market Value	15,760	6,222.70	14,766.61	550.62	1,510.91	4,478.31
Market to Book	15,760	3.10	2.91	1.60	2.26	3.44
Analyst Following	15,760	5.86	4.93	2.00	4.00	8.00
CRSP/Compustat/ I/B/E/S Population	N	Mean	Std Dev	25th Pctl	Median	75th Pctl
Total Assets	92,652	4,932.50	14,938.60	196.39	719.95	2,576.57
Sales	92,582	633.57	1,681.66	26.45	103.15	389.49
Market Value	91,290	3,393.32	9,647.16	202.69	604.46	1,963.73
Market to Book	91,059	2.89	3.41	1.41	2.11	3.42
Analyst Following	92,784	4.63	4.44	1.00	3.00	6.00

	Sample		CRSP/Compustat/ I/B/E/S Population	
	N	Percentage	N	Percentage
Incidence of loss	2,378	15%	25,367	27%
Incidence of missing analyst consensus forecasts	4,909	31%	31,145	34%
Industry composition:				
Cnsmr	3,027	19%	14,556	16%
HiTec	2,159	14%	23,397	25%
Hlth	1,404	9%	10,516	11%
Mfg	4,284	27%	16,131	17%
Finl	2,862	18%	17,538	19%
Other	2,024	13%	10,646	11%

Panel B: Stickiness of call initiation time

Define stickiness as 100% consistency	no. of firms	percentage
stickiness	742	41.7%
no stickiness	1,038	58.3%
Total	1,780	

Define stickiness as 75% of frequency	no. of firms	percentage
stickiness	1,274	71.6%
no stickiness	506	28.4%
Total	1,780	

Table 3: Descriptive Statistics (Continued)

Panel C: Holding exclusively morning calls or afternoon calls

	no. of firms	percentage
Only in morning (before 12:00)	983	55.2%
Only in afternoon	260	14.6%
no stickiness	537	30.2%
Total	1,780	

Panel D: For firms with sticky calls time, incidences of holding call at atypical time by news types

	Change time	No change
Loss or miss analyst consensus	378	4,755
	7.4%	92.6%
Profit and meet-or-beat analyst consensus	542	7,593
	6.7%	93.3%
	Chi-square=2.40, p= 0.1213	

Panel E: Call time related to meet/beat or miss

	Morning	Afternoon
Meet or Beat(SUE>=0)	9,722	3,317
	74.6%	25.4%
Miss (SUE<0)	4,281	1,521
	73.8%	26.2%
	Chi-square=1.26, p= 0.2603	

Note:

Table 3 presents sample descriptive statistics. Panel A compares sample firms to the CRSP/Compustat/I/B/E/S universe. Panel B-E show descriptive statistics related to conference call start times and their "stickiness". We start with 19,004 calls initiated in Eastern and Central time zones by 1,943 firms, but further exclude firms with only one call, and use 18,841 calls by 1,780 firms in this analysis.

Table 4: Time-of-Day as a Determinant of Residual Tone

	ResidToneQuestion	*ResidToneAnswer*	*ResidToneQ&A*
EST_Hour	0.019 ***	0.026 ***	0.026 ***
	(4.09)	(5.47)	(6.25)
Intercept	-0.213 ***	-0.279 ***	-0.278 ***
	(4.35)	(5.56)	(6.45)
Std. Errors Clustered by Firm	Yes	Yes	Yes
N	15,760	15,760	15,760
R-square	0.0022	0.0071	0.0085

Note:

This table presents the results from the regressions of residual tone against the time of the call (measured in Eastern Standard Time) for all EST and CST calls initiated from 8:00 to 15:59. T-statistics are shown in parentheses. All variables are defined in greater detail in Appendix B. *, **, *** indicate coefficients that are significantly different from zero at the 0.10, 0.05, and 0.01 level, respectively, using a two-tailed test with standard errors clustered by firm.

Table 5: Comparison of East Coast to West Coast Calls

	ResidToneQuestion	*ResidToneAnswer*	*ResidToneQ&A*
PST	0.075 ***	0.143 ***	0.133 ***
	(3.01)	(5.77)	(6.27)
Local_Hour	0.014 **	0.030 ***	0.028 ***
	(2.55)	(6.14)	(6.34)
Intercept	-0.174 ***	-0.329 ***	-0.312 ***
	(3.04)	(6.31)	(6.72)
Std. Errors Clustered by Firm	Yes	Yes	Yes
N	12,380	12,380	12,380
R-square	0.0020	0.0134	0.0144

Note:

This table presents the results of residual tone regressions on the local start time of the calls (i.e., EST for East Coast calls and PST for West Coast calls) for all EST and PST calls initiated during the 8:00 to 15:59 EST window. T-statistics are shown in parentheses. All variables are defined in greater detail in Appendix B. *, **, *** indicate coefficients that are significantly different from zero at the 0.10, 0.05, and 0.01 level, respectively, using a two-tailed test with standard errors clustered by firm.

Table 6: Switcher Analyses

Panel A: "AM-PM switchers" compared to matched pair non-switching firms

# treated group: 270	AM-PM Switcher		Paired t-test		Wilcoxon signed rank test		signed test	
	Treat	Control	T stats	Significance (one sided)	S stats	Significance (one sided)	M stats	Significance (one sided)
delta_ResidToneQ&A	0.006	-0.058	1.673	**	2,128.5	**	12.5	*
delta_ResidToneQuestion	0.079	-0.006	1.024		1,354.5		13.0	*
delta_ResidToneAnswer	-0.021	-0.080	1.489	*	2,008.5	*	9.5	

Panel B: "PM-AM switchers" compared to matched pair non-switching firms

# treated group: 264	PM-AM Switcher		Paired t-test		Wilcoxon signed rank test		signed test	
	Treat	Control	T stats	Significance (one sided)	S stats	Significance (one sided)	M stats	Significance (one sided)
delta_ResidToneQ&A	-0.096	-0.009	-1.909	**	-2,314.0	**	-17.0	**
delta_ResidToneQuestion	-0.134	0.014	-2.039	**	-2,450.0	**	-21.0	***
delta_ResidToneAnswer	-0.080	-0.024	-1.101		-1,284.0		-7.0	

Panel C: "Time switchers"

	delta_ResidToneQuestion	*delta_ResidToneAnswer*	*delta_ResidToneQ&A*
delta_Hour	0.039 **	0.019 *	0.024 **
	(1.88)	(1.36)	(1.92)
EarlierCall	0.086 *	0.031	0.044
	(1.52)	(0.79)	(1.27)
*EarlierCall*delta_Hour*	-0.022	-0.022 *	-0.021 *
	(-0.98)	(-1.43)	(-1.52)
Intercept	-0.082 **	-0.068 **	-0.070 ***
	(-1.83)	(-2.20)	(-2.54)
N	2,123	2,123	2,123
R-square	0.0036	0.0010	0.0020

Table 6: Switcher Analyses (Continued)

Note:

We address the issue of omitted variables by using subsamples of call time switchers, implicitly holding constant all firm characteristics other than call start time. We analyze a subsample of firms that have switched from a morning call time in the previous quarter to an afternoon call time in the current quarter ("AM-PM switchers") in Panel A, and vice versa ("PM-AM switchers) in Panel B. Each switching firm call observation is matched to a non-switching firm call on the basis of market capitalization, 2-digit SIC code, morning versus afternoon call time in the previous quarter, and the earnings fiscal year and quarter to which the call relates. In Panel C, we examine a subsample of firms that switch their call time within the day ("time switchers"). All variables are defined in greater detail in Appendix B. *, **, *** indicate coefficients that are significantly different from zero at the 0.10, 0.05, and 0.01 level, respectively, using a one-tailed test.

Table 7: Regressions Controlling for the Potential Endogeneity of the Call Time Decision

Panel A: Determinants of the decision to hold an afternoon conference call

	Prob(*Afternoon*=1)			
Lag_Afternoon	2.323	***	2.326	***
	(33.47)		(33.72)	
HiTec	-0.286	**	-0.279	**
	(-2.34)		(-2.30)	
InvestIntense	-1.303	***	-1.334	***
	(-6.07)		(-6.26)	
absSUE	0.042			
	(0.97)			
BadNews	0.012			
	(0.29)			
Size	-0.001			
	(-0.02)			
logAnalyst	-0.072			
	(-1.60)			
FQ4	0.046			
	(0.84)			
EquiDepend	-0.004			
	(-0.60)			
Intercept	-1.581	***	-1.673	***
	(-10.16)		(-36.89)	
Std. Errors Clustered by Firm	Yes		Yes	
N	14,748		14,748	
Pseudo_R-square	0.4570		0.4559	

Panel B: Second stage of the Heckman model

	ResidToneQuestion	*ResidToneAnswer*	*ResidToneQ&A*
EST_Hour	0.021***	0.030***	0.030***
	(3.68)	(5.22)	(6.07)
Lambda	-0.008	-0.026**	-0.025**
	(0.57)	(2.05)	(2.37)
Intercept	-0.231***	-0.322***	-0.321***
	(3.90)	(5.41)	(6.32)
Std. Errors Clustered by Firm	Yes	Yes	Yes
N	14,748	14,748	14,748
R-square	0.0024	0.0074	0.0091

Table 7: Controlling for the Potential Endogeneity of the Call Time Decision (Continued)

Panel C: Regressions including potential endogenous variables

	ResidToneQuestion	*ResidToneAnswer*	*ResidToneQ&A*
EST_Hour	0.021 ***	0.028 ***	0.028 ***
	(3.79)	(5.21)	(6.10)
Lag_Afternoon	-0.019	-0.009	-0.017
	(0.82)	(0.43)	(0.91)
HiTec	-0.030	0.027	0.011
	(1.32)	(1.18)	(0.58)
InvestIntense	0.025	0.009	0.022
	(0.48)	(0.19)	(0.53)
Intercept	-0.233 ***	-0.309 ***	-0.313 ***
	(3.90)	(5.31)	(6.27)
Std. Errors Clustered by Firm	Yes	Yes	Yes
N	14,748	14,748	14,748
R-square	0.0027	0.0074	0.0089

Note:

In this table, we address the potential endogeneity between the firm's choice of call time and the tone of the conversations. Panel A reports results of a probit regression of the firm's choice to hold an afternoon call. Panel B presents results of the second stage of the Heckman model that includes the inverse Mills ratio computed from the regressions reported in Panel A. Panel C presents the results from regressions that include the significant determinants of afternoon call time choice from Panel A regressions directly in the residual tone regressions. In order to be included in these analyses, the *Lag_Afternoon* variable must be available (i.e., firms had to appear in our dataset at least twice). Because the first observation for each firm is lost in creating the lag variable, the number of observations available for the regressions in this table is somewhat reduced relative to earlier tests of the time-of-day's influence on residual call tone. T-statistics are shown in parentheses. All variables are defined in greater detail in Appendix B. *, **, *** indicate coefficients that are significantly different from zero at the 0.10, 0.05, and 0.01 level, respectively, using a two-tailed test with standard errors clustered by firm.

Table 8: Stock Return Response Tests

	5 Hour Event	[1,5] Trading day	[6, 15] Trading day	[16,30] Trading day	[5 Hour Event, 30 Trading day]
EconToneQ&A	-0.004 **	-0.022 ***	-0.002	0.007	-0.021 ***
	(2.08)	(7.55)	(0.50)	(1.54)	(2.96)
DiurnalToneQ&A	-0.015 ***	0.001	-0.005	0.030 **	0.003
	(2.66)	(0.13)	(0.50)	(2.38)	(0.17)
UnexplainedToneQ&A	-0.001 **	-0.002 **	-0.001	0.001	-0.003 *
	(2.35)	(2.40)	(0.51)	(1.03)	(1.67)
Intercept	-0.002 **	-0.007 ***	0.001	0.007 ***	0.000
	(2.16)	(6.01)	(0.52)	(4.06)	(0.01)
Std. Errors Clustered by Firm	Yes	Yes	Yes	Yes	Yes
N	14,517	14,517	14,517	14,517	14,517
R-square	0.0013	0.0049	0.0001	0.0007	0.0009

Note:

In this table, we examine the market's pricing of the three components of tone from the Q&A portion of the call: *EconToneQ&A*, which is the tone that is explained by economic news and firm fundamentals; *DiurnalToneQ&A*, which is tone that is attributable to the time-of-day effect; and *UnexplainedToneQ&A*, which is the tone that is unrelated to either economic or firm fundamentals, nor to the time-of-day. All variables are defined in greater detail in Appendix B. *, **, *** *, **, *** indicate coefficients that are significantly different from zero at the 0.10, 0.05, and 0.01 level, respectively, using a two-tailed test with standard errors clustered by firm.