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# Uncertain tone, asset volatility and credit default swap spreads

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A B S T R A C T

We examine the relationship between uncertain linguistic tone and credit default swap (CDS) spreads. Using an event study approach, we first show that uncertain linguistic tone in 10-Q/K filings is positively associated with CDS spread changes incremental to positive and negative tone and incremental to the response implied by equity market reactions to the same information. We further demonstrate that the relationship of uncertain tone to CDS spreads manifests largely through its impact on asset volatility. We show that this effect is driven by firms with high leverage and is stronger among firms with shorter relative to longer maturities. Our findings contribute to growing research into credit market reactions to non-quantitative information by demonstrating a positive relationship between credit market responses and uncertainty disclosure language, and that this relationship is mediated by investors' implied asset volatility estimates.

## Introduction

Emerging empirical capital markets research documents important market responses to the non-quantitative linguistic tone embedded in financial reports. Early research in this area observes equity market responses to linguistic tone, incremental to the reactions attributable to quantitative information in disclosures.[1] Subsequent recent research further demonstrates separate market responses in the larger and more sophisticated credit markets (Wang 2021; Chiu, Guan, and Kim 2018; Ertugrul, Lei, Qiu, and Wan 2017). We extend this line of research in two key ways. We first document a relationship between credit default swap ('CDS') responses and *uncertain linguistic tone*, incremental to positive and negative linguistic tone, and incremental also to the responses implied by equity market reactions to the same information. Second, using uncertain tone as a research lens, we further examine the channel through which credit investors impound linguistic tone into prices.

While research has explored the relationship between credit market responses and linguistic tone, we know very little about the channel through which new non-quantitative information manifests. We address this gap. Using insights from classical structural models of credit risk, we isolate the impact of *leverage* and *asset volatility* on credit spreads (Kelly, Manzo, and Palhares 2019; Ericsson, Jacobs, and Oviedo 2009; Campbell and Taksler 2001; Black and Scholes 1973; Merton 1974). Our central thrust is that uncertain tone in financial disclosures elevates investors' perception of asset risks, leading investors to update their estimates of asset volatility, which

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[1] Recent studies investigating the value relevance of non-quantitative financial information to equity investors include Huang, Teoh, and Zhang (2014), Jegadeesh and Wu (2013), Loughran and McDonald (2013), Loughran and McDonald (2011), Feldman, Govindaraj, Livnat, and Segal (2010), and Li (2008).

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in turn impacts credit spreads.

We focus our investigation on uncertain tone, which reflects management's prospective concern for the firm's future strategy, competitive position and/or financial wellbeing. Uncertain tone bears conceptual links to asset volatility, which embeds investor's uncertainty about firms' future states.[2] Uncertain tone has been shown to drive important credit consequences, such as the cost of debt, debt covenants, and loan spreads (Chiu et al. 2018; Ertugrul et al. 2017). Our proxy for uncertain linguistic tone is the abnormal proportion of total words in the 10-Q/K that are listed in the Loughran and McDonald uncertain word list (e.g., *approximate*; *uncertain*; *indefinite*; *possible*) (see Loughran and McDonald 2011). We use total words rather than restricting to subsections (e.g. risk disclosures) to allow for uncertain tone to manifest in all areas of financial reports and to allow for investors to construct beliefs from the totality of the report. To the extent that other report areas do not embed tone or are disregarded by investors, this choice biases against results. We also control for the uncertain tone that would be expected given firms' quantitative fundamentals (e.g. risk, performance, etc.) following Huang et al. (2014) (see also Kim, Craft, and Ryan 2013).

We investigate credit market responses as reflected in CDS spreads. CDS spreads possess several advantages relative to corporate bond spreads as a research setting for credit market responses. CDSs function similar to credit 'insurance policies' that pay off only in the event of a target firm's default and thus reflect default risk almost exclusively (and not, for instance, choices for risk-free benchmarks, liquidity, taxes, or other frictions). Second, CDS markets are standardized, highly liquid and available at a daily frequency, permitting spreads to reflect updated beliefs (Augustin, Subrahmanyam, Tang, and Wang 2014). Third, structural models of CDS spread formation decompose CDS spreads into discrete determinants. This enables our study to isolate and test *asset volatility* incrementally to the leverage consequences already implied by prior studies (Kelly et al. 2019; Duffie and Lando 2001; Merton 1974).

We perform three primary tests. We use a sample constructed from WRDS-Markit daily CDS pricing data for U.S. firms over the fifteen-year period from 2001 to 2016, examining the impact of abnormal uncertain disclosure tone on CDS spread changes. We measure CDS spreads relative to the median CDS spread for all other firms with the same debt rating (e.g. 'AAA', etc.) to control for systematic sources of uncertainty. Following Callen, Livnat, and Segal (2009), we utilize an event study design to minimize the possibility that CDS spreads impound other information, examining an eleven-day (-5, +5) event window centered on the 10-Q/K filing date. We include several market-level and firm-level controls for other determinants of CDS spreads.

We first regress abnormal uncertain disclosure tone on CDS spread changes, controlling for stock returns to ensure that the effects we observe are incremental to known effects. Equity and debt markets are mechanically linked both empirically (see Lok and Richardson 2011), and structurally, through their impact on market leverage. We find a positive relation between abnormal uncertain tone scores and changes in CDS spreads. Firms with greater abnormal uncertain tone scores experience an economically and statistically significant increase in their CDS spreads. We find that a one standard deviation increase in abnormal uncertain tone scores corresponds with an increase in incremental CDS spreads of 2.78 basis points (bps) relative to the mean change across all firms of 0.47 bps.

Following Kelly et al. (2019), we next infer asset volatility from observed credit spreads. We examine to what extent variation in abnormal uncertain linguistic tone is associated with variation in implied asset volatility. We find a statistically significant relationship between abnormal uncertain tone and changes in implied asset volatility. We further confirm the significance of the indirect relationship of abnormal uncertain tone and CDS spreads via asset volatility using the Sobel (1982) test.

Next, we investigate cross-sectional variation in these effects by firm leverage and CDS maturity. We predict that the observed effects will be strongest among firms with the greatest uncertainty, such as those closest to default and nearest to maturity (see Duffie and Lando 2001). Consistent with predictions, we observe that abnormal tone is significantly related to both changes in asset volatility and to CDS spreads among high leverage firms but not low leverage firms. Consistent with Chiu et al. (2018) and Arora, Richardson, and Tuna (2014), we also observe a downward trend by maturity for both changes in asset volatility and changes in CDS spreads. We interpret this evidence as suggesting that the relationship of abnormal uncertain linguistic tone to asset volatility appears driven by firms with high leverage, and is more pronounced for shorter relative to longer maturities. Together, our tests address whether and how credit investor responses as reflected in CDS spreads coincide with uncertain disclosure tone. In addition, these tests also account for other known effects, including those observed in equity market settings (Huang et al. 2014, Lok and Richardson 2011).[3]

We confirm that our results are robust to several alternative explanations documented in prior research. First, we address the possibility that the observed effects may be driven by concurrently released positive or negative financial information that causes managers to change tone and investors to update beliefs (see Shivakumar et al., 2011). We build subsamples that exclude firms with 8-K releases or with management guidance releases that overlap with our event window. Our results hold under the revised samples. We also explore the possibility that the findings we attribute to uncertain disclosure tone reflect other textual factors such as readability of 10-Q/K filings or positive and negative tone (Loughran and McDonald 2014; Lehavy, Li and Merkley 2011; Li 2008). We control for readability measures and negative tone in our baseline regression with no change in results, suggesting that our results persist even after controlling for other documented tone dimensions. Finally, we demonstrate that our results also hold after controlling for alternate window sizes, sample constructions, and time periods.

Our results make several important contributions to the understanding of credit markets and to the understanding of market

[2] Uncertain linguistic tone also shares some conceptual similarities with *accounting uncertainty* as modeled by Duffie and Lando (2001). We discuss this further in Section 2.

[3] We also investigate the role of abnormal uncertain tone in forecasting actual defaults. We find no significant default predictability using abnormal tone. Since credit spreads are driven by actual default probabilities and risk premia, this suggests that the impact of abnormal uncertain tone on credit spread is likely due to its impact on risk premia.

consequences of linguistic tone. Foremost, we contribute to the important work of linking market responses to the channels through which they manifest. We do so by identifying one such novel channel, asset volatility. Importantly, we utilize an event study design in our analysis, a more robust design that builds on prior non-quantitative research in debt markets employing panel designs (see Callen, Livnat, and Segal 2009). We additionally confirm the significance of indirect relationship of abnormal uncertain tone to change in CDS spreads through asset volatility following Sobel (1982). Our study also extends important research investigating the credit market consequences of non-quantitative information (Wang 2021; Chiu et al 2018; Ertugrul et al. 2017). In particular, we document a novel association between credit market responses as reflected in CDS spreads and non-quantitative information, uncertain linguistic tone, incremental to positive and negative tone and incremental also to the response implied by equity market reactions to the same information. We also show that the asset volatility effects of abnormal uncertain tone vary by leverage and maturity, with high leverage firms and shorter maturities driving the effects we observe.

More practically, our study contributes to regulatory discussions on the apparent gap between firms facing default/going-concern uncertainty and those which disclose it (OSC 2010). Our findings on the relationship between linguistic tone and CDS spreads contribute to evidence suggesting that managers are aware of and implicitly communicate these uncertainties even when they are unwilling to explicitly convey them (see also Mayew, Sethuraman, and Venkatachalam 2015).

Lastly, we also contribute to a growing textual analysis literature (Loughran et al., 2016). Researchers have documented the usefulness of textual analysis in generating value-relevant information to investors using tone, content and sentiment in newspaper articles (e.g., Tetlock 2007), corporate disclosures (e.g., Loughran and McDonald 2011, Li 2008), press releases (e.g., Engelberg 2008) as well as investor message boards (e.g. Antweiler and Frank 2004) and its impact on equity valuations. To our knowledge, this is the first study to investigate the channels through which linguistic tone manifests into credit derivative pricing. We show that uncertain disclosure tone in accounting reports provides value-relevant information to credit markets incremental to positive and negative tone, and does so primarily through investors' estimates of asset volatility. Our research contributes to a rapidly emerging research space in which a growing number of nonquantitative dimensions of accounting reports, in both specific subsections and overall, are shown to correspond with firm- and market-level outcomes. Our study employs a broad construction of uncertain tone, utilizing the entire accounting report, following the logic that investors, too, process reports completely. We document a market-based relationship with expected default risks, derived from uncertain linguistic tone that is incremental to responses implied by negative linguistic tone. We further show that this relationship exists incrementally to other linguistic dimensions such as readability and negative tone.

The remaining paper proceeds as follows. Section 2 details related research and motivates our primary predictions. Section 3 describes our sample construction and highlights our research design. Section 4 reports the results from our empirical tests related to uncertain disclosure tone and CDS spreads. Section 5 discusses alternative explanations for our results and enumerates related robustness tests. Section 6 concludes the paper with discussion of our evidence, its limitations, and opportunities for future research.

## Background & hypothesis development

### *Non-quantitative dimensions of disclosures*

Financial reports such as SEC filings are rich in value-relevant quantitative financial information, but also convey rich non-quantitative information as well. While this information has been critical to market analysts for years, capital markets research has only recently developed systems for categorizing and analyzing textual communication (see Loughran et al., 2016; Li 2010 for recent reviews). A growing textual analysis research body acknowledges that managers embed signals of their knowledge of the firm's 'economic reality' into communication both intentionally and unintentionally, based on the sum of deliberate and latent language choices (Loughran et al., 2016).

Recent research has documented a variety of important capital market responses to the linguistic tone embedded in reports, in both equity markets (e.g. equity prices, stock price crash risk, see Huang et al. 2014; Jegadeesh and Wu 2013; Loughran and McDonald 2013; Loughran and McDonald 2011; Feldman et al. 2010; Li 2008) and, incrementally, in credit markets (e.g. lending terms and credit default swap spreads, see Wang 2021; Chiu et al. 2018; Ertugrul et al. 2017). Several equity market studies examine the effects of various types of linguistic tone, observing that dimensions of linguistic tone are associated both with market responses to accounting disclosures and with firms' current and future performance (Allee and Deangelis, 2015; Mayew et al. 2015; Loughran and McDonald 2013; Davis et al., 2012; Feldman et al. 2010).[4] For instance, two studies link uncertain linguistic tone to equity market responses, observing that ambiguous tone is associated with future stock price risk (Ertugrul et al. 2017), and that uncertain tone is associated with greater IPO returns and future price volatility (Loughran and McDonald 2013).

### *Credit markets and CDS spreads*

Empirical capital market research has given considerable attention to credit markets, which are both impressive in magnitude and central to financial markets (BIS 2018). Guided by theory emphasizing default risks in credit investments, this research has extensively documented determinants of default risk and its relationship to accounting (Givoly, Hayn, and Katz 2017; Demerjian and Owens 2016;

[4] Research further suggests that managers sometimes use tone to mislead investors, where abnormal tone is associated with both current positive returns and negative future returns, negative future performance, and greater future litigation risk (Huang et al. 2014; Rogers, van Buskirk, and Zachman 2011).

Correia et al., 2012; Jacobson, Lindé, and Roszbach 2006; Altman and Saunders 1997; Ohlson 1980; Altman 1968), credit market responses to financial information via determinants of default risk (Jung, Soderstrom, and Yang 2013; Lok and Richardson 2011; Longstaff 2010; Callen et al. 2009; Tang 2009), and/or investigating the impact of default risk factors on the amount and structure of credit issuances (e.g. public/private, covenants, etc.) (Demerjian 2017; Doblas-Madrid and Minetti 2013; Ball, Robin, and Sadka 2008; Bharath, Sunder, and Sunder 2008). Separate research observes credit market responses to non-financial information such as positive and negative linguistic tone, observing a relationship to default risk and credit pricing (Wang 2021; Chiu et al. 2018; Ertugrul et al. 2017). We discuss these studies in greater detail below.

Credit default swaps, which function as a manner of insurance against default, have enabled credit market researchers to examine default risks more directly because these instruments reflect default risk in a very straightforward way (see Ericsson et al. 2009). Recent investigations examine the relationship between CDS spreads and earning announcements (Callen et al. 2009), cash flow news in management forecasts (Shivakumar et al. 2011), the quality of internal control and cost of debt (Tang, Tian, and Yan 2015), the adoption of International Financial Reporting Standards (Bhat et al., 2014), risk factor disclosures in accounting reports (Chiu et al. 2018) among others.[5]

Recognizing these advantages, theoretical research on CDS spreads has also generated useful structural models of CDS spread formation (Kelly et al. 2019; Ericsson et al. 2009; Duffie and Lando 2001; Campbell and Taksler, 2003; Black and Scholes 1973; Merton 1974). In addition to advancing our understanding of CDS spreads, these models enable archival research to isolate and investigate the channels through which market events manifest into CDS spreads. We follow Kelly et al. (2019), which extends a family of models that broadly decompose CDS spreads into two channels, *leverage* and *asset volatility* (Ericsson et al. 2009; Campbell and Taksler, 2003; Black and Scholes 1973; Merton 1974). The logic of these models stems from the idea that CDS spreads reflect default risk and that default risk is increasing in the magnitude of firms' debt burden, reflected through its leverage, and also increasing in uncertainty about firms' future state, broadly classified as volatility. The present study follows this line of research, investigating the relationship between this information and credit investors' pricing.

In particular, we extend the important work of three closely related studies that link non-quantitative information, including dimensions of linguistic tone, to credit outcomes. Ertugrul et al. (2017) investigate the effect of ambiguous tone on borrowing costs as reflected in loan spreads and contract terms, examining how tone corresponds with firm choices such as loan maturity. We focus on market consequences as reflected in CDS spreads, arguably a cleaner measure of credit risk. We further examine changes rather than levels in our study and employ cross sectional analyses, demonstrating that the relationships we examine vary by CDS maturity and firm leverage. Wang (2021) most closely relates to the current investigation; that study examines the effects of net positive and negative tone on CDS spreads. Positive and negative tone relate to shifts in the *mean* of performance beliefs. Our investigation examines uncertain tone, which relates more to shifts in the *variance* of performance beliefs. We further extend our analysis, examining the mediating channel of asset volatility. Chiu et al. (2018) investigate the materiality of risk factor disclosures in 10-K reports, utilizing CDS spreads as its primary dependent measure. However, Chiu et al. (2018) does not examine tone per se, employing a binary indicator reflecting the presence or absence of this non-quantitative risk information in a subsection of the report rather than the entire report.

### *Hypothesis development*

We posit that firm managers who are uncertain about their firms' future prospects will intentionally and/or unintentionally embed linguistic signals of their uncertainty into disclosures such as by selecting less certain words. Managers with low confidence in the firm's business strategy, competitive position within the industry and/or future financial wellbeing feel constrained in which words they may use to portray present and future prospects based on reputational and legal risks, resulting in less certain (more uncertain) language in their disclosures. To the extent that this is true, uncertain tone will create valuation uncertainty in investors' minds. Under the theoretical model of Duffie and Lando (2001), which models CDS spreads in terms of underlying leverage and volatility, this valuation uncertainty should lead investors to increase their estimate(s) of volatility for any given level of leverage.

Given the centrality of asset volatility to CDS spreads, asset volatility increases would manifest in CDS spreads. This effect should be distinct from, and thus incremental to, any tendency of investors to also update *leverage* through its impact on equity. Thus, we predict that the effect of abnormal uncertain linguistic tone on CDS spreads will be robust to controlling for market leverage. Separately, dimensions of CDS spreads such as asset volatility can be inferred from CDS spreads. We also predict that abnormal uncertain linguistic tone will be positively related to asset volatility. Prior research has not investigated this relationship and we are not aware of results that would inform the channel through which investors react to tone.

HYPOTHESIS 1a. *Abnormal uncertain linguistic tone will be positively related to CDS spreads after controlling for market leverage.*
HYPOTHESIS 1b. *Abnormal uncertain linguistic tone will be positively related to asset volatility.*

Several secondary cross-sectional predictions follow from our theory and related models. Foremost, precision in asset volatility estimates may become more valuable as companies approach critical thresholds such as default, and may thus matter more for firms with high relative to low financial leverage. We therefore predict that the relationship of abnormal uncertain tone to asset volatility

[5] See Griffin and Cahan (2014) and Augustin et al. (2014) for a comprehensive review of accounting and finance research on CDS. Research also shows that default risk information priced into CDS spreads mechanically link credit and equity markets (see Lok and Richardson 2011).

and credit spreads will be greater for firms with relatively higher leverage (which are more likely to default) as compared to those with lower leverage.[6]

HYPOTHESIS 2a. *The relationship between abnormal uncertain linguistic tone and CDS spreads will be greater for high leverage firms than for low leverage firms.*

HYPOTHESIS 2b. *The relationship between abnormal uncertain linguistic tone and asset volatility will be greater for high leverage firms than for low leverage firms.*

Classic structural models generate spreads that are lower for shorter maturities than the spreads that are commonly observed empirically. To bridge earlier models to observed credit spreads, Duffie and Lando (2001) incorporate an additional type of uncertainty into their model, deemed *accounting uncertainty*, that weighs more heavily on short-term maturities. We infer maturity-specific asset volatility from CDS spreads using the classic structural model of Merton (1974). According to Duffie and Lando (2001), short term spreads are more sensitive to accounting uncertainty than long term spreads (see also Chiu et al. 2018). We therefore predict that the relationship of accounting uncertainty and credit spreads will be greater for shorter maturities than it is for longer maturities.[7]

HYPOTHESIS 3a. *The relationship between abnormal uncertain linguistic tone and CDS spreads will be greater for short maturities than for long maturities.*

HYPOTHESIS 3b. *The relationship between abnormal uncertain linguistic tone and asset volatility will be greater for short maturities than for long maturities.*

## Sample & research design

### *Sample*

We test our hypotheses using a sample constructed from CDS data obtained from the WRDS Markit CDS database for the period 2001–2016. Markit records composite end-of-day CDS spreads for firms with highly liquid contracts and is widely used both in practice and in research. Our sample begins with the daily data for all single name CDS contracts with 1-, 3-, 5-, 7- and 10-year maturity. Following prior research, we utilize 5-year CDS contracts for our primary analyses, as they are most liquid and have the best coverage in the database (Chiu et al. 2018; Bhat et al. 2014; Shivakumar et al. 2011). However, we also use 1-, 3-, 7- and 10-year CDS contracts in our test of hypothesis 3, which relates to variation in credit spreads by maturity. To maintain uniformity in contracts, we limit our sample to CDS spreads for senior unsecured debt with a modified restructuring (MR) clause and denominated in US dollars (see also Chiu et. al. 2018; Jorion and Zhang 2007).

We combine CDS spread data with disclosure tone data collected from WRDS SEC analytics suite-Readability and Sentiment Analysis database. The database records the lexical features of the language used in SEC-filed financial reports (e.g. readability and linguistic complexity) including the uncertainty/weak-model words and total words employed for each report. We construct our measure of abnormal uncertain tone for each quarterly 10-Q/K disclosure using the count of words from the report that appear in the Loughran-McDonald Financial-Uncertainty words list (Fin-Unc) and then scale by the total number of words in the same report (see Loughran and McDonald 2011).[8] Utilizing total words allows for uncertain tone to become embedded in all areas of the report, and also allows for investors to holistically weigh the tone embedded across the entire report.[9] To the extent that management is not involved in crafting language (i.e. boilerplate) and/or investors do not fully process reports, this will tend to bias against results. We expand on Huang et al. (2014) in isolating the *abnormal* portion of uncertain tone, which controls for tone levels implied by other known determinants (discussed in Section 3.2). We match the daily CDS data with the disclosure tone data on the SEC filing date by linking *permco, gvkey, cik* unique identifiers. Our initial match contains 809 firms and 25,008 firm-quarter observations.

We also construct a number of control variables using firm-specific and economy-wide data. We rely on COMPUSTAT for firm-specific control variables such as *size* and *leverage*, merged with our sample using *gvkey*. We use the CRSP database to obtain equity prices, daily stock return and the number of shares outstanding. With this data, we calculate the *event period equity return* (*EPER*), and *realized volatility* (*Rvol*), matched using *cusip*. We use the Standard & Poor credit rating of the firm (*Rate*). We further match to IBES

[6] To the extent that linguistic tone imposes additional costs to extract in investor time and attention, differential response coefficients are consistent with models of limited investor attention.

[7] Merton (1974) and related models are compatible with accounting uncertainty but require the effects to manifest through either leverage or asset volatility (that is, the third term is implicitly set to 0).

[8] The Loughran-McDonald Financial-Uncertainty words list includes 285 words that denote uncertainty through emphasis on imprecision rather than risk, particularly in business/financial context (e.g. *approximate, uncertain, depends, unpredictable* and *indefinite)*. Other readability measures such as Flesch-Kincaid index, Fog index, Coleman-Liau index, Harvard general inquirer negative index used in robustness analyses are also taken from WRDS SEC analytics suite.

[9] Other research isolates the tone conveyed in specific subsections of accounting reports and/or in a subset of accounting reports (e.g. 10-K vs. 10-Q). Chiu et al. (2018) investigates the materiality of Risk Factor Disclosures in 10-Ks, demonstrating the materiality of this subsection by documenting market responses to an indicator variable reflecting the presence of this subsection. Ertugrul et al. (2017) measure readability and ambiguous tone using entire 10-Ks (but not 10-Qs), observing a relationship between this linguistic information and certain credit market responses. Wang (2021) utilizes both 10-Ks and 10-Qs, but isolates tone conveyed in Risk Disclosures made in the Management Discussion & Analysis subsection, a conservative design choice given the abundance of textual information in other areas of 10-Q/K filings.

unadjusted EPS and IBES mean analyst forecast for the 90-day period preceding the 10-Q/K filing to calculate *earnings surprise* (*SUE*). Our final sample has 22,532 firm-quarter observations and 755 firms.

Lastly, we build several economy-wide control variables using data obtained from two sources. We use the Federal Reserve Economic Data (FRED) database of the Federal Reserve Bank of St. Louis to determine the *Risk-free rate* (*Rf*) using the three-month treasury-bill yield, *Term Spread* (*TS*) measured as the difference between the yields of a ten-year and one-year government bond, and *Default Spread* (*DS*) measured as the difference between the yield of Moody's Baa corporate bond and the yield of the ten-year constant maturity treasury bond. We use data from the Chicago Board Options Exchange (CBOE) website to construct measures of aggregate investors' risk appetite or market uncertainty by using a measure of implied volatility from S&P 500 index option prices with 30-day maturity, better known as *VIX*.

*Empirical design*

We examine the relationship of abnormal uncertain disclosure tone to changes in CDS spreads and implied asset volatility using a short-window event study design. Event studies use firms as their own control in the non-window sample, mitigating a number of research challenges including heteroscedasticity concerns (Callen et al. 2009).

The primary dependent variable in our tests is abnormal uncertain tone (*Abtone*), which reflects the unexplained uncertain tone qualitatively disclosed in 10-Q/K fillings. We measure the abnormal portion of uncertain tone following Huang et al. (2014). Specifically, our measure of abnormal uncertain tone is the error term resulting from the following regression:

$$\begin{aligned} UncTone_{it} = {} & \beta_0 + \beta_1 ROA_{it} + \beta_2 QRet_{it} + \beta_3 Size_{it} + \beta_4 Leverage_{it} + \beta_5 Rvol_{it} + \beta_6 \sigma ROA_{it} + \beta_7 FirmAge_{it} + \beta_8 nBsegs_{it} \\ & + \beta_9 nGEOsegs_{it} + \beta_{10} Loss_{it} + \beta_{11} \Delta ROA_{it} + \beta_{12} SUE_{it} + \beta_{13} SUEAF_{it} + timeFE + FirmFE + \varepsilon_{it} \end{aligned} \tag{1}$$

See Appendix A for definitions. The dependent variable (*UncTone*) is the expected proportion of total words in 10-Q/K filings that are uncertain (e.g., *approximate*, *uncertain*, *indefinite*, *possible*) as defined by Loughran and McDonald (2011). The independent variables are various firm-level controls, for return on assets (*ROA*), stock return over the previous quarter (*QRet*), as well as firm size (*Size*) and leverage (*Leverage*). Following Huang et al. (2014) we further control for the standard deviation of return on assets ($\sigma ROA$), age of firm (*Firm Age*), change in return on assets (ΔROA), and earnings surprise (*SUE*). Lastly, we control for realized volatility (*Rvol*), number of business segments(n*Bsets*), number of geographical segments (n*GEOsegs*), earnings surprise (*SUE*) and analyst estimates (*SUEAF*), and we include a dummy variable for firm-years experiencing an earnings loss (*Loss*). Firm fixed effects and time fixed effects are included and we cluster standard errors at firm level.

We measure CDS spread changes by subtracting the median change experienced by all other firms with the same credit rating to control for systematic market responses. This approximates the expected change in CDS spreads implied by other firms, enabling our study to associate otherwise unexplained credit market responses in a short event window with the abnormal uncertain linguistic tone conveyed within concurrently released accounting reports. Changes designs also represent a more conservative test of CDS spread determinants (Ericsson et al. 2009).

Our baseline regression specification is the following:

$$\begin{aligned} \Delta CDSSpread_{[-5,+5]} = {} & \beta_0 + \beta_1 Abtone_{it} + \beta_2 \Delta Size_{it} + \beta_3 \Delta Leverage_{it} + \beta_4 SUE_{it} + \beta_5 Rate_{it} + \beta_6 Rvol_{[-63,-1]} + \beta_7 EPER_{[-5,+5]} \\ & + \beta_8 \Delta VIX_{[-5,+5]} + \beta_9 \Delta Rf_{[-5,+5]} + \beta_{10} \Delta TS_{[-5,+5]} + \beta_{11} \Delta DS_{[-5,+5]} + FEs + \varepsilon \end{aligned} \tag{2}$$

The dependent variable, *ΔCDS Spread,* is the unexpected change in CDS spreads relative to the median change within the same credit rating over an eleven-day window [-5, +5] centered on the 10-Q/K disclosure date. The primary test variable in the regression is abnormal uncertain tone (*Abtone*) as defined above. Firm-specific controls include changes in firm size (*ΔSize*), leverage (*ΔLeverage*), measured relative to their value in the previous quarter.[10] We include a measure for Earnings Surprise (*SUE*) to control for concurrent performance information introduced in the report, separate from the tone used to describe performance. We also include same-period credit rating (*Rate)* which controls for differences in credit worthiness, returns (*EPER*) and return volatility (*Rvol)* which control for the response implied by equity market reactions to the same information.

We include changes in market-wide variables that occur during the [-5, +5] event window using variables described in Section 3.1: risk-free rate (*ΔRf*), Implied Volatility of S&P 500 Index options (*ΔVIX*), Term Spread (*ΔTS*), and Default Spread (*ΔDS*). Our regression model includes time and industry fixed effects, and includes clustered standard errors at the firm level. All variable definitions also available in Appendix A.

In addition to indirectly controlling for the impact of market leverage through *EPER,* we also conduct regressions which directly account for changes in asset volatility estimates.

$$\begin{aligned} \Delta AssetVol_{[-5,+5]} = {} & \beta_0 + \beta_1 Abtone_{it} + \beta_2 \Delta Size_{it} + \beta_3 \Delta Leverage_{it} + \beta_4 SUE_{it} + \beta_5 Rate_{it} + \beta_6 Rvol_{[-63,-1]} + \beta_7 EPER_{[-5,+5]} \\ & + \beta_8 \Delta VIX_{[-5,+5]} + \beta_9 \Delta Rf_{[-5,+5]} + \beta_{10} \Delta TS_{[-5,+5]} + \beta_{11} \Delta DS_{[-5,+5]} + FEs + \varepsilon \end{aligned} \tag{3}$$

We extract changes in asset volatility estimates (*ΔAssetVol)*, a nonlinear transformation which inverts credit spreads, controlling for their leverage, to isolate the portion of CDS spread changes not explained by changes in leverage. We first infer asset volatility

[10] Our results are robust to alternative measures of leverage. In untabulated analysis, we substitute *Book-to-Market (B/M)* ratio in place of *Leverage.* All results hold for this alternate specification. We do not include both *B/M* and *Lev* in the same regression because of multicollinearity issues.

**Table 1**
Descriptive Statistics.

| **Panel A: Distribution of Variables – Levels** | | | | | | |
|---|---|---|---|---|---|---|
| Variable Name | Mean | STD | P25 | Median | P75 | N |
| *CDS Spread (bps)* | 196.825 | 495.871 | 44.995 | 87.376 | 192.615 | 26,003 |
| *Abtone (%)* | 0 | 0.347 | −0.235 | −0.018 | 0.206 | 25,074 |
| *AssetVol* | 0.339 | 0.131 | 0.264 | 0.331 | 0.397 | 25,814 |
| *Size* | 8.973 | 1.412 | 8.042 | 8.959 | 9.863 | 26,635 |
| *Leverage* | 0.489 | 0.216 | 0.323 | 0.465 | 0.639 | 26,637 |
| *Rate* | 9.028 | 3.130 | 7 | 9 | 10 | 27,317 |
| *EPER (bps)* | 100.314 | 12.443 | 97.117 | 100.170 | 103.177 | 25,870 |
| *SUEAF* | 0.647 | 0.917 | 0.250 | 0.540 | 0.911 | 24,468 |
| *SUE* | −0.003 | 0.106 | −0.002 | 0.001 | 0.002 | 24,357 |
| *Rvol* | 0.345 | 0.221 | 0.209 | 0.287 | 0.403 | 25,876 |
| *VIX* | 19.983 | 9.339 | 13.670 | 17.570 | 22.690 | 27,258 |
| *Risk free rate (Rf) (bps)* | 141.609 | 171.172 | 9 | 32 | 225 | 27,202 |
| *Term Spread (TS) (bps)* | 205.123 | 111.346 | 148 | 222 | 283 | 27,202 |
| *Default Spread (DS) (bps)* | 267.277 | 84.766 | 206 | 265 | 306 | 27,325 |

| **Panel B: Distribution of Variables – Changes** | | | | | | |
|---|---|---|---|---|---|---|
| Variable Name | Mean | STD | P25 | Median | P75 | N |
| Δ*CDS Spread (bps)* | 0.466 | 109.866 | −3.229 | 0 | 3.236 | 25,742 |
| Δ*AssetVol* | 0 | 0.031 | −0.006 | 0 | 0.005 | 25,051 |
| Δ*Size* | 0.973 | 29.692 | −7.008 | 2.569 | 11.328 | 25,856 |
| Δ*Leverage* | 0 | 0.047 | −0.022 | −0.002 | 0.018 | 25,867 |
| Δ*ROA* | 0 | 0.048 | −0.005 | 0 | 0.005 | 26,587 |
| Δ*VIX* | 0.255 | 3.710 | −1.330 | −0.080 | 1.520 | 27,258 |
| Δ*Rf (bps)* | −1.216 | 10.959 | −2 | 0 | 2 | 27,130 |
| Δ*TS (bps)* | −0.091 | 15.866 | −9 | −1 | 8 | 27,130 |
| Δ*DS (bps)* | 0.878 | 9.191 | −3 | 1 | 5 | 27,258 |

| **Panel C: Correlation Table** | Δ*CDS* | *Abtone* | Δ*Assetvol* | Δ*Size* | Δ*Leverage* | *EPER* | Δ*Rvol* | *Rate* | *SUE* | Δ*VIX* | Δ*Rf* | Δ*Term spread* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Δ*CDS* | – | | | | | | | | | | | |
| *Abtone* | **0.015** | – | | | | | | | | | | |
| Δ*Assetvol* | **0.889** | **0.014** | – | | | | | | | | | |
| Δ*Size* | **−0.138** | 0.006 | **−0.105** | – | | | | | | | | |
| Δ*Leverage* | **0.061** | 0.002 | 0.004 | **−0.650** | – | | | | | | | |
| *EPER* | **−0.153** | −0.005 | **−0.083** | **0.133** | **−0.136** | – | | | | | | |
| Δ*Rvol* | **0.034** | 0.000 | −0.005 | **−0.087** | **0.057** | **0.067** | – | | | | | |
| *Rate* | **0.029** | 0.007 | **0.019** | −0.012 | **−0.029** | **0.020** | **0.371** | – | | | | |
| *SUE* | **0.065** | 0.000 | **−0.025** | **0.065** | **−0.026** | **−0.034** | 0.009 | −0.005 | | | | |
| Δ*VIX* | **0.052** | −0.007 | **0.014** | **−0.084** | **0.094** | **−0.166** | **−0.039** | **0.036** | 0.002 | – | | |
| Δ*Rf* | **−0.031** | −0.012 | −0.005 | **0.117** | **−0.139** | **0.075** | **−0.125** | **−0.018** | **0.018** | **−0.200** | – | |
| Δ*Term spread* | −0.005 | 0.004 | **0.015** | **−0.019** | **0.017** | **0.020** | **0.090** | **−0.015** | −0.004 | **−0.178** | **−0.500** | – |
| Δ*Default spread* | **0.069** | 0.002 | **0.083** | **−0.128** | **0.146** | **−0.076** | **−0.107** | **0.040** | **−0.013** | **0.327** | **−0.218** | **−0.289** |

This table reports the descriptive statistics of all the important variables used in regressions. Panel A reports the levels, panel B reports the changes panel C reports the correlations. CDS Spread is obtained from WRDS-Markit on the day of the event (basis points). Abnormal tone (*Abtone*) defined as the residual from the regression of *UncTone* of various control variables (see Appendix B). Asset Volatility (*AssetVol*) is the inferred asset volatility from CDS spreads using Merton (1974) model. *Size* is the logarithm of the market capitalization of the firm. *Leverage* is the book value of short-term liabilities plus long-term liabilities divided by the sum of the market value of the firm's equity and the book value of short term plus long-term liabilities. *M/B* is the market value of equity divided by the book value of the total assets of the firm. Event-period equity return (*EPER*) is the cumulative daily equity returns calculated over the event period. *Rvol* is the realized volatility of the firm's daily equity returns over the past year. Credit rating (*Rate)* is the Standard & Poor credit rating of the firm. Analyst Forecast (*SUEAF*) mean analyst forecast from IBES during the 90-day period before the disclosure of earnings. Earnings Surprise (*SUE*) is calculated as the actual IBES unadjusted EPS minus the mean analyst forecast during the 90-day period before the disclosure of earnings, scaled by the price per share at the end of the quarter. Risk free rate (*Rf*) is the three-month U.S. Treasury bill rate. *Term Spread* is the difference between ten-year U.S Treasury bond rate and the three-month U.S. Treasury bill rate. *Default Spread* is the Moody's corporate bond yield relative to the yield on ten-year Treasury bond rate. All the firm specific change variables represent the change in value from the previous quarter. Δ*CDS Spread,* Δ*VIX,* Δ*Rf,* Δ*TS,* and Δ*DS* represent the change in value over [-5, +5] event period. Δ*CDS* Spread is the change in five-year maturity CDS spreads over the event period relative to the median change in CDS spreads in the same credit rating group across the same period.

Bolded values indicate statistical significance levels at the 5% level.

(*AssetVol*) following Kelly et al. (2019). *ΔAssetVol* is the unexpected change in implied asset volatility over an eleven-day window [-5, +5] centered on the 10-Q/K disclosure date. All other variables are constructed as above.

## Results

### Summary statistics

Table 1 presents descriptive statistics for all variables employed in our analysis. In Panel A, we report descriptive statistics for *levels* variables. We note that the mean (median) CDS spread on the 10-Q/K filing date is 197 (87) basis points. The mean value of the abnormal disclosure uncertainty tone, our primary independent variable, is 0 %. The 25th and 75th percentile values for *Abtone* are 0.235 % and 0.206 % respectively. We further observe that summary statistics for *Abtone* suggest that it is not highly skewed and does not suffer from the presence of outliers.

Firms covered in our sample are both large (average market value of $20.7B) and highly skewed (median market value is roughly 1/3 of the mean, $7.7B). Given skewness, we use the natural logarithm of firm size in all empirical specifications, including in measures of firm size changes. The mean (median) *leverage* in our sample is 0.489 (0.465). Equity market responses are captured with cumulative event period equity return (*EPER*) and annualized realized volatility of the firm's daily equity returns for the past year (*Rvol*). *EPER* has a mean (median) of 100.314 basis points (100.117) while *Rvol* has a mean (median) value of 0.345 (0.287). Macro controls include measures of general market conditions including the volatility index (*VIX*) of S&P 500 options and the three-month risk-free rate (*Rf*). Lastly, we report also macro-level controls relating to debt markets specifically such as the term spread (*TS*) and default spread (*DS*), which are defined respectively as the ten-year U.S. treasury bond rate minus the risk-free rate, and Moody's Baa Corporate bond rate relative to the ten-year treasury bond rate. We observe that *TS* has a mean (median) of 2.05 (2.22) percent and that *DS* has a mean (median) of 2.67 (2.65) percent.

In Panel B, we report descriptive statistics for *changes* variables. Our primary dependent variable, *ΔCDS Spread*, measures the unexpected change in CDS spreads around the disclosure event after subtracting median changes for all firms with the same credit rating. The mean change in CDS spreads in our sample is around one basis point, but varies significantly in our sample (25th and 75th percentile values of approximately −3 and + 3 basis points respectively. We also observe that our measure of asset volatility estimates (*ΔAssetVol*) ranges between −0.6 % and 0.5 % at the 25th and 75th percentiles, respectively, and does not appear to be highly skewed. In Panel C, we report a univariate correlation matrix of our primary research variables. The correlation coefficient between our primary dependent variable, *ΔCDS Spread*, and our primary independent variable, *Abtone,* is 0.015. The correlation between *ΔCDS Spread* and equity returns (*EPER*) −0.153, consistent with CDS markets sharing some information linkages with equity markets. The correlation between *ΔCDS Spread* and change is firm size (*ΔSize*) is −0.138. *Abtone* demonstrates no correlation of 0.10 or greater in absolute terms with other RHS variables.

### Hypothesis tests

#### *The impact of abnormal uncertain tone on CDS spreads and asset volatility*

We first examine the relationship between uncertain disclosure tone in 10-Q/K filings and the change in five-year CDS spreads and Asset Volatility measured in short windows around disclosure event dates. In Table 2, Columns (A) and (B) we report results from panel regressions estimated as in equation (1). The dependent variable is *ΔCDS Spread,* the change in CDS spreads over an eleven-day window [-5, +5] centered on the 10-Q/K disclosure date. The change in firm-specific variables are relative to the prior quarter. Market-level change variables reflect the change in market condition around the disclosure event date. In all our specifications, we include industry-quarter fixed effects and the clustered standard errors at the firm level.

The specification in Column (A) includes all firm-level controls, including equity market returns (*EPER*) during the [-5, +5] period, which controls for the response implied by equity market returns (see Lok and Richardson 2011), and change in market leverage (*ΔLeverage*), which is an input into investors' *leverage* estimates. We also control for the realized volatility of the firm's daily equity return (*Rvol*) over the previous quarter [-63, −1] relative to the disclosure date. We note that the coefficient on the event period cumulative return (*EPER*) indicates that firms with lower cumulative daily returns have a larger change in CDS spreads. These results are consistent with the intuition that lower equity returns and drops in firm equity relate to elevated default risk as reflected by an increase in CDS spreads. The coefficient on abnormal uncertain tone measure is positive and significant. The specification in Column (B) includes also market-level controls. The market level controls do not affect the magnitude or significance of the abnormal uncertain tone measure but result in some improvement in $R^2$. Our measure of abnormal uncertain tone continues to be positive and statistically significant. This suggests that firm CDS spreads increase in conjunction with aggregate default risk.

Overall, the results in Columns (A) and (B) support H1a. We conclude that firms with relatively higher abnormal uncertain disclosure tone have a higher change in five-year CDS spreads. This result is also economically significant. The coefficient in Column (B) indicates that an increase in abnormal uncertain disclosure tone from 25th to 75th percentile (an increase of 0.44 %) is associated with a 2.78 basis points higher change in our median-adjusted CDS spreads around the event window.

In Columns (C) and (D), we report results from panel regressions estimated as in equation (2). In equation (2), the dependent variable is *ΔAssetVol,* the change in implied asset volatility over an eleven-day window [-5, +5] centered on the 10-Q/K disclosure date. Implied asset volatility is inferred following Kelly et al. (2019), which backs asset volatility out of CDS spreads, holding market leverage constant. All other variables are measured as above. All firm- and market-level control variables are specified as above.

The specification in Column (C) includes all firm-level controls. The coefficient on abnormal uncertain tone measure is positive and

**Table 2**
The Relationship of Abnormal Uncertain Tone to Change in CDS Spreads and Asset Volatility[†].

**Panel A: Abnormal Uncertain Tone (*Abtone*)**

| | Change in CDS Spreads$_{i,[-5,+5]}$ | | Change in Asset Volatility$^{\dagger}_{i,[-5,+5]}$ | |
|---|---|---|---|---|
| | (A) | (B) | (C) | (D) |
| *Abtone* | 6.284** | 6.318** | 1.559** | 1.570** |
| | (0.011) | (0.011) | (0.032) | (0.031) |
| $\Delta Size_{i,t}$ | −75.225** | −75.446** | −14.861** | −14.960** |
| | (0.012) | (0.012) | (0.021) | (0.020) |
| $\Delta Leverage_{i,t}$ | −170.232* | −171.153* | −79.829*** | −80.249*** |
| | (0.081) | (0.079) | (0.003) | (0.002) |
| $SUE_{i,t}$ | −36.253 | −36.761 | −3.300 | −3.372 |
| | (0.348) | (0.343) | (0.698) | (0.692) |
| $Rate_{i,t}$ | 1.509* | 1.438 | 0.304 | 0.285 |
| | (0.093) | (0.112) | (0.140) | (0.170) |
| $Rvol_{i,t}$ | −817.115 | −817.982 | −220.246 | −218.723 |
| | (0.185) | (0.185) | (0.109) | (0.111) |
| $EPER_{i,t}$ | −1.246* | −1.223* | −0.131 | −0.134 |
| | (0.072) | (0.075) | (0.222) | (0.215) |
| $\Delta VIX_t$ | | 0.775** | | 0.045 |
| | | (0.024) | | (0.611) |
| $\Delta Rf_t$ | | 0.013 | | 0.132*** |
| | | (0.905) | | (0.000) |
| $\Delta TS_t$ | | 0.026 | | 0.084*** |
| | | (0.760) | | (0.001) |
| $\Delta DS_t$ | | 0.548*** | | 0.237*** |
| | | (0.001) | | (0.000) |
| Adj R2 | 0.093 | 0.095 | 0.053 | 0.057 |
| N | 22,532 | 22,532 | 21,864 | 21,864 |

**Panel B: Path Analysis**

| Direct Path | Mediated Path | | Total mediated Path |
|---|---|---|---|
| p(*Abtone*, Δ*CDS*)= b1 | p(*Abtone*, Δ*AssetVol*) = a1 | p(Δ*AssetVol* Δ*CDS*) = b2 | = a1*b2 |
| 6.318** | 1.570** | 3.195*** | 5.016** |
| (0.011) | (0.031) | (0.000) | (0.034)° |

[†] - Reported in 1000's.

This table reports the effect of uncertain tone in 10-Q/K statements on the changes in *CDS spreads* and *Asset Volatility* around the event window [-5, +5] days of the disclosure. The dependent variable in Columns A and B is the change in five-year maturity CDS spreads from a week before the disclosure to a week after the disclosure [-5, +5]. The dependent variable in Columns C and D is the change in Asset Volatility from a week before the disclosure to a week after the disclosure [-5, +5]. The independent variable of interest is the abnormal tone (*Abtone*) defined as the residual from the regression of *UncTone* of various control variables (see Appendix B). The other independent variables consist of firm controls: change in *size*; change in *leverage*; earnings surprise (*SUE*); credit rating (*Rate*); event period return (*EPER*); realized volatility (*Rvol*), and market wide controls: change in *VIX*; change in risk-free rate (*Rf*); change in term spread (*TS*); change in default spread (*DS*). All the firm specific change variables represent the change in value from the previous quarter. Δ*CDS Spread,* Δ*VIX,* Δ*Rf,* Δ*TS,* and Δ*DS* represent the change in value over [-5, +5] event period. The coefficients of Columns C and D are multiplied by 1000. The standard errors are clustered at firm level and the p-values are reported below the coefficient estimates. The sample period is from 2001 to 2016.

Statistical significance levels of 1%, 5% and 10% are indicated by ***, **, and * respectively.

This table reports the results of a path analysis on the effects of *Abtone* on Δ*CDS,* mediated through Δ*AssetVol.* The independent variable of interest is the abnormal tone (*Abtone*) defined as the residual from the regression of *UncTone* of various control variables (See Appendix B). The dependent variable is the change in five-year maturity CDS spreads from a week before the disclosure to a week after the disclosure [-5, +5] (Δ*CDS*). The mediating variable is the change in Asset Volatility (Δ*AssetVol*) from a week before the disclosure to a week after the disclosure [-5, +5]. The sample period is from 2001 to 2016. Regressions include all control variables reported in Panel A. The standard errors are clustered at firm level and the p-values are reported below the coefficient estimates.

° Sobel Test Statistic = 2.115.

Statistical significance levels of 1%, 5% and 10% are indicated by ***, **, and * respectively.

significant. The specification in Column (D) includes also market-level controls. As with Columns (A) and (B), abnormal uncertain tone continues to be positive and statistically significant. The results reported in Columns (C) and (D) support H1b. We conclude that firms with relatively higher abnormal uncertain disclosure tone have a higher change asset volatility.

We next confirm the significance of the indirect effect of abnormal uncertain tone on CDS spreads via asset volatility. Following Mayew et al. (2015) and DeFond et al. (2016), we utilize the Sobel (1982) test to estimate the significance of indirect effects. Table 2, Panel B presents the results of our analysis. We observe direct associations of *Abtone* with both *ΔCDS Spread* (coeff = 6.318*,* p = 0.011) and with *ΔAssetVol* (coeff = 1.570*,* p = 0.031), and direct associations of *ΔAssetVol* with *ΔCDS Spread* (coeff = 3.195 p < 0.001). We further observe a significant indirect effect of *Abtone* on *ΔCDS Spread* via *ΔAssetVol* (Sobel test statistic = 2.115, p-value = 0.034). We conclude that change in asset volatility mediates the relationship of abnormal uncertain tone and changes in CDS spreads.

*The impact of leverage on abnormal uncertain tone and asset volatility*

We next make predictions about cross-sectional variation in the relationship between abnormal uncertain linguistic tone and our two dependent variables, *ΔCDS Spread* and *ΔAsset Volatility*. We argue that credit investors will impound abnormal uncertain linguistic tone to a greater extent when greater estimate precision is needed, such as when companies approach critical thresholds like default. This implies that the impact of abnormal uncertain disclosure tone on CDS spread changes should be larger for firms with relatively greater leverage, because these firms are more to likely to default, *ceteris paribus*. Accordingly, we perform subsample regressions, splitting our sample at the median value of leverage (*Leverage*) to ensure balanced sample sizes. Subsample tests provide insight into the comparative weighting of abnormal disclosure tone for firms with high versus low leverage.

We formally test hypothesis 2a and 2b in Table 3. In Columns (A) through (C) we report results from regressions specified as in equation (1), examining the relationship of abnormal uncertain tone to CDS spreads, for low leverage (Column (A)) and high leverage (Column B)) subsamples, and in a pooled regression employing a term that interacts *Abtone* with an indicator for high leverage firms (*HLev*). In Columns (D) through (F), we repeat the analyses, specified as in equation (2), using asset volatility as the dependent measure. Consistent with our hypotheses, we observe in Columns (C) and (F) that interaction term *Abtone X HLev* is statistically significant. We conclude that hypotheses 2a and 2b are supported, consistent with credit markets differentially responding to abnormal uncertain linguistic tone depending on cross-sectional differences in *leverage*, and doing so incrementally to other known cross-sectional determinants of CDS spreads (Ericsson et al. 2009).

*The impact of maturity on abnormal uncertain tone and asset volatility*

Lastly, we investigate hypotheses 3a and 3b, which investigate variation in the relationship of abnormal uncertain linguistic tone to

**Table 3**

The Relationship of Abnormal Uncertain Tone to the Change in CDS Spreads Asset Volatility[†], by Leverage.

| | Change in CDS Spreads$_{i,[-5,+5]}$ | | | Change in Asset Volatility$_{i,[-5,+5]}$ † | | |
|---|---|---|---|---|---|---|
| | Low Leverage | High Leverage | Full Sample | Low Leverage | High Leverage | Full Sample |
| | (A) | (B) | (C) | (D) | (E) | (F) |
| *Abtone* | 0.466 | 22.138** | 1.281 | −0.154 | 6.602** | −0.023 |
| | (0.525) | (0.026) | (0.190) | (0.731) | (0.015) | (0.962) |
| *HLev* | | | 0.357 | | | 1.002 |
| | | | (0.928) | | | (0.185) |
| *Abtone X HLev* | | | 23.195** | | | 7.263** |
| | | | (0.024) | | | (0.010) |
| $\Delta Size_{i,t}$ | −9.042 | −117.968** | −75.412** | −1.635 | −22.508** | −14.875** |
| | (0.455) | (0.022) | (0.012) | (0.613) | (0.026) | (0.021) |
| $\Delta Leverage_{i,t}$ | −9.881 | −339.793* | −172.067* | −48.809*** | −114.809** | −80.999*** |
| | (0.808) | (0.077) | (0.079) | (0.000) | (0.028) | (0.002) |
| $SUE_{i,t}$ | −348.091 | −4.624 | −36.788 | −39.721 | 2.288 | −3.361 |
| | (0.214) | (0.901) | (0.343) | (0.199) | (0.784) | (0.693) |
| $Rate_{i,t}$ | 0.413 | 2.754 | 1.412* | −0.098 | 0.873* | 0.236 |
| | (0.163) | (0.213) | (0.079) | (0.229) | (0.090) | (0.207) |
| $EPER_{i,t}$ | −0.979 | −2.371*** | −1.221* | −0.061 | −0.421*** | −0.132 |
| | (0.114) | (0.001) | (0.075) | (0.543) | (0.007) | (0.218) |
| $Rvol_{i,t}$ | −274.047 | −1272.524 | −817.287 | −102.263 | −329.567 | −224.192 |
| | (0.416) | (0.178) | (0.197) | (0.178) | (0.117) | (0.110) |
| $\Delta VIX_t$ | 0.118 | 2.195*** | 0.777** | −0.212*** | 0.594** | 0.047 |
| | (0.680) | (0.004) | (0.023) | (0.002) | (0.013) | (0.598) |
| $\Delta Rf_t$ | 0.033 | 0.156 | 0.014 | 0.139*** | 0.152 | 0.133*** |
| | (0.532) | (0.723) | (0.901) | (0.000) | (0.199) | (0.000) |
| $\Delta TS_t$ | −0.006 | 0.111 | 0.024 | 0.069*** | 0.129 | 0.083*** |
| | (0.883) | (0.719) | (0.781) | (0.000) | (0.111) | (0.001) |
| $\Delta DS_t$ | 0.301*** | 1.264** | 0.545*** | 0.153*** | 0.489*** | 0.235*** |
| | (0.000) | (0.022) | (0.001) | (0.000) | (0.001) | (0.000) |
| Adj R2 | 0.179 | 0.128 | 0.096 | 0.079 | 0.102 | 0.058 |
| N | 17,163 | 5,368 | 22,532 | 16,629 | 5,234 | 21,864 |

This table reports the effect of uncertain tone in 10-Q/K statements on the changes in *CDS spreads* and *Asset Volatility* around the event window [-5, +5] days of the disclosure. The dependent variable in Columns A through C is the change in five-year maturity CDS spreads from a week before the disclosure to a week after the disclosure [-5, +5]. The dependent variable in Columns D through F is the change in Asset Volatility from a week before the disclosure to a week after the disclosure [-5, +5]. The independent variable of interest is the abnormal tone (*Abtone*) defined as the residual from the regression of *UncTone* of various control variables (see Appendix B). *HLev* is a dummy variable equal to 1 if the firm's leverage ratio is in the top quartile. The other independent variables consist of firm controls: change in *size*; change in *leverage*; earnings surprise (*SUE*); credit rating (*Rate*); event period return (*EPER*); realized volatility (*Rvol*), and market wide controls: change in *VIX*; change in risk-free rate (*Rf*); change in term spread (*TS*); change in default spread (*DS*). All the firm specific change variables represent the change in value from the previous quarter. *ΔCDS Spread, ΔVIX, ΔRf, ΔTS,* and *ΔDS* represent the change in value over [-5, +5] event period. The coefficients of Columns D through F are multiplied by 1000. The standard errors are clustered at firm level and the p-values are reported below the coefficient estimates. The sample period is from 2001 to 2016. Statistical significance levels of 1 %, 5 % and 10 % are indicated by ***, **, and * respectively.

[†] - Reported in 1000's.

**Table 4**
The Effects of Abnormal Uncertain Tone, by Term Length.

**Panel A: The Effect of Abnormal Uncertain Tone on the Change in CDS Spreads by Term Length**

| | Change in CDS Spreads$_{i,[-5,+5]}$ | | | | | |
|---|---|---|---|---|---|---|
| | 1 yr | 3 yr | 5 yr | 7 yr | 10 yr | 10y-1y |
| | (A) | (B) | (C) | (D) | (E) | (F) |
| *Abtone* | 10.779** | 7.701*** | 6.318*** | 5.349** | 4.328* | −6.486** |
| | (0.012) | (0.007) | (0.011) | (0.032) | (0.078) | (0.024) |
| All Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Adj R2 | 0.086 | 0.107 | 0.095 | 0.119 | 0.120 | 0.041 |
| N | 20,475 | 21,496 | 22,532 | 21,376 | 21,058 | 19,895 |

**Panel B: The Effect of Abnormal Uncertain Tone on the Change in Asset Volatility† by Term Length**

| | Change in Asset Volatility$_{i,[-5,+5]}$ † | | | | | |
|---|---|---|---|---|---|---|
| | 1yr | 3yr | 5yr | 7yr | 10yr | 10y-1y |
| | (A) | (B) | (C) | (D) | (E) | (F) |
| *Abtone* | 1.914* | 1.755** | 1.570*** | 1.611** | 1.270 | 0.437 |
| | (0.053) | (0.024) | (0.031) | (0.035) | (0.109) | (0.523) |
| All Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Adj R2 | 0.050 | 0.060 | 0.057 | 0.079 | 0.084 | 0.101 |
| N | 19,774 | 20,857 | 21,864 | 20,736 | 20,426 | 19,218 |

† - Reported in 1000's.
This table reports the effect of uncertain tone on 10-Q and 10-K statements on the changes in CDS spreads and Asset Volatility around the event window [-5, +5] days of the disclosure. The dependent variables in panel A and panel B are respectively $\Delta CDS$ and $\Delta AssetVol$ of varying term lengths. The independent variable of interest is the abnormal tone (*Abtone*) defined as the residual from the regression of *UncTone* of various control variables (see Appendix B). The other independent control variables are the same as in Table 2. Standard errors clustered at firm level and p-values reported below coefficient estimates. Industry X quarter fixed effects included in all regressions. Sample period is from 2001 to 2016.
Statistical significance levels of 1%, 5% and 10% are indicated by ***, **, and * respectively.

CDS spreads by maturity length. We predict that abnormal uncertain tone will weigh more heavily on short-term maturities because these maturities face the greatest estimation uncertainty (e.g. 'accounting uncertainty' in Duffie and Lando 2001). In Table 4, we use information from the term structure of CDS spreads, examining changes in 1-, 3-, 5-, 7-, and 10-year CDS spreads. In Column (F), we additionally report results comparing 1-year and 10-year maturities. In Panel A, our dependent variable is change in CDS Spreads (*ΔCDS Spread*), using equation (1). In Panel B, our dependent variable is change in asset volatility (*ΔAssetVol*), using equation (2). We include both firm-specific and market-level controls for all maturities.

Beginning with Panel A, we observe a positive and significant coefficient on abnormal uncertain disclosure tone (*Abtone*) for all maturities. We additionally observe in Column (F) that the effect is significantly lower for 10-year maturities relative to 1-year maturities. In Panel B, we repeat this analysis but with changes in asset volatility as our dependent variable, observing again a positive and significant coefficient on abnormal uncertain disclosure tone for 1-, 3-, 5-, and 7-year maturities but not statistically significant for 10-year maturities. We further observe that the difference (Column F) between 10-year and 1-year maturities, although lower, is not statistically significant. In both panels, we descriptively observe that the coefficient on abnormal uncertain disclosure tone decreases monotonically from 1-year to 10-year maturities for both the low-leverage and high-leverage partitions. We conclude that hypothesis 3 is partially supported, consistent with the association of abnormal uncertain tone and CDS spreads being stronger for shorter maturities, although results for asset volatility are mixed.

## Robustness & alternative explanations

In robustness analysis, we ensure that our results are robust to phenomena documented in prior research. In particular, we explore the possibility that our evidence reflects material non-textual information released concurrently with 10-Q/K filings or other textual features that are not reflecting uncertain tone *per se.*[11]

### *Material non-textual information*

One potential explanation for the credit market response we observe is that firms may disclose other financial results and/or announcements concurrently with (or in) 10-Q/K filings that lead credit markets to update CDS spreads and, separately, also lead firm managers to employ different tone. To better understand if our results reflect concurrent information releases, we construct alternate samples excluding sources of material information outside of the 10-Q/K that might impact CDS spreads (e.g., Shivakumar et al. 2011). We do this by constructing subsamples of firm-quarters without 8-K and/or management guidance releases that occur during the corresponding event window.

[11] For simplicity, we tabulate robustness tests using only one dependent variable, change in CDS spreads (*ΔCDS Spread*). We additionally confirm but do not tabulate that results when change in asset volatility (*ΔAsset Volatility*) is replaced as the primary dependent variable.

**Table 5**
Earning Surprise and Special Firm-Specific Events.

| | Change in CDS Spreads$_{i,[-5,+5]}$ Excluding 8-K Statements (A) | Excluding Management Guidance (MG) (B) | Excluding 8-K and MG (C) |
|---|---|---|---|
| *Abtone* | 4.361* | 7.000** | 5.003* |
| | (0.054) | (0.013) | (0.059) |
| All Controls | Yes | Yes | Yes |
| Adj R2 | 0.080 | 0.097 | 0.083 |
| N | 14,685 | 19,877 | 12,709 |

This table reports the effect of uncertain tone on 10-Q/K statements on the changes in CDS spreads around the event window [-5, +5] days of the disclosure. The dependent variable is the change in five-year maturity CDS spreads from a week before the disclosure to a week after the disclosure [-5, +5]. The independent variable of interest is the abnormal tone (*Abtone*) defined as the residual from the regression of *UncTone* of various control variables (see Appendix B). The other independent variables are the same as in Table 2. All the firm specific change variables represent the change in value from the previous quarter. Δ*CDS Spread,* Δ*VIX,* Δ*Rf,* Δ*TS,* and Δ*DS* represent the change in value over the event period. We include controls for industry and quarter fixed effects. The standard errors are clustered at firm level and the p-values are reported below the coefficient estimates. The sample period is from 2001 to 2016.
Statistical significance levels of 1%, 5% and 10% are indicated by ***, **, and * respectively.

Table 5 presents the results of these tests. In Columns (A) through (C), we observe also that uncertain tone remains statistically significant in all limited concurrent release subsamples. We conclude that the relationship between uncertain tone and CDS spreads is not driven by concurrent releases of other financial information.

*Other textual dimensions*

Another potential explanation for our evidence is that credit investors are responding to other textual dimensions of 10-Q/K filings that we may be attributing to our measure of abnormal uncertain tone. Research observes that firms with unfavorable news issue more complex disclosures (Lo et al., 2017; Li 2010; Bloomfield 2008), which are associated with higher search costs and hence greater riskiness (Lehavy et al. 2011; Li 2008). Thus, differences in abnormal uncertain tone could plausibly correspond with differences in readability and negative or positive tone. To control for the possibility that readability, rather than uncertain tone, drives our results we re-run our primary regression with various measures of readability/complexity as additional controls. We consider four measures of readability/complexity advanced in Li (2008) and Loughran and McDonald (2014), which include the log of file size, Kincaid index, Fog index and Coleman-Liau index. We include each of these indices separately as an additional control together with all firm and market controls. Table 6 presents our results of our regression analysis including these additional controls. The relationship we observe between uncertain tone and CDS spreads remains statistically significant in all four regressions.

To control for the possibility that positive or negative tone rather than uncertain tone drives our results, we rerun our primary analysis three times. We include a simple measure of negative tone (*Negtone*), a measure that nets positive and negative tone together (*Net*), and one additional measure that nets optimistic and pessimistic tone, controlling for the same firm's prior tone in reports issued in the previous four quarters (*Net_Pes_Sur*) (Wang 2021; Loughran and McDonald 2013; Loughran and McDonald 2011). We present the results from these regressions controlling first for these measures of negative tone in Columns (E), (F), and (G) of Table 6. We observe that abnormal uncertain tone remains statistically significant in all three regressions.[12] We also acknowledge that Loughran and McDonald (2013) argue that negative and weak modal words may reflect similar underlying ambiguity as the uncertain words and that prior research observes credit market reactions to positive and negative tone. Results from regressions controlling for weak modal (*Weak Modal*) and alternatively defined negative tone (*Harvard IV Neg*) tone are presented in Columns (H) and (I) of Table 6. We observe that *Abtone* remains statistically significant in both regressions. We conclude that our results are robust to controlling for positive and negative tone.

*Other robustness*

Lastly, we replicate our results under several alternative specifications to ensure that our results are not somehow driven by idiosyncrasies in our research design. We first rerun our baseline regression with varying lengths of event window centered around the 10-Q/K disclosure filing date such as (i) three-day window ([-1, +1]); (ii) seven-day window ([-3, +3]); (iii) twenty-one-day window ([-10, +10]); and (iv) six-day window ([0, +5]). Table 7, Columns (A) through (D) present results of these regressions. Our conclusions remain unchanged after these modifications. Second, we run our analyses excluding financial firms, who tend to be more regulated, with differing capital structures than non-financial firms, and who often act as the dealers and counterparties in CDS contracts. Column (E) of Table 7 reports these results. We find that excluding financial firms from our sample does not impact our inferences. Lastly, we

[12] In untabulated analysis, we confirm the significance of the association of CDS spreads to positive and negative tone (*Net_Pes_Sur*) in regressions that do not account for uncertain linguistic tone (*Abtone*). Uncertain tone seems to subsume that association when both tone variables are included in the same model.

**Table 6**
Other Textual Dimensions.

| | Change in CDS Spreads$_{i,[-5,+5]}$ Readability | | | | Other Tone | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | (A) | (B) | (C) | (D) | (E) | (F) | (G) | (H) | (I) |
| *Abtone* | 6.328** | 6.758*** | 6.757*** | 6.105** | 6.319** | 6.829*** | 6.267** | 5.776** | 6.294** |
| | (0.011) | (0.006) | (0.007) | (0.014) | (0.012) | (0.008) | (0.012) | (0.033) | (0.012) |
| **ln*(File Size)*** | −0.200 | | | | | | | | |
| | (0.777) | | | | | | | | |
| *Fog Index* | | 0.547 | | | | | | | |
| | | (0.191) | | | | | | | |
| *Flesch-Kincaid* | | | 0.559 | | | | | | |
| | | | (0.216) | | | | | | |
| *Coleman-Liau* | | | | 0.658 | | | | | |
| | | | | (0.186) | | | | | |
| *Negtone* | | | | | −0.578 | | | | |
| | | | | | (0.995) | | | | |
| *Net (Pos-Neg)* | | | | | | −0.088 | | | |
| | | | | | | (0.910) | | | |
| *Net_Pes_Sur* | | | | | | | 1.519 | | |
| | | | | | | | (0.195) | | |
| *Weak Modal* | | | | | | | | 1.350 | |
| | | | | | | | | (0.683) | |
| *Harvard IV Neg* | | | | | | | | | −91.180 |
| | | | | | | | | | (0.235) |
| All Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Adj R2 | 0.095 | 0.095 | 0.095 | 0.095 | 0.095 | 0.095 | 0.095 | 0.095 | 0.095 |
| N | 22,532 | 22,532 | 22,532 | 22,532 | 22,532 | 22,532 | 22,532 | 22,532 | 22,532 |

This table reports the effect of uncertainty tone on 10-Q/K statements on the changes in CDS spreads around the event window [-5, +5] days of the disclosure. The dependent variable is the change in five-year maturity CDS spreads from a week before the disclosure to a week after the disclosure [-5, +5]. The independent variable of interest is the abnormal tone (*Abtone*) defined as the residual from the regression of *UncTone* of various control variables (see Appendix B). ln*(File Size)* is the log of 10-Q/K filings size (in megabytes), as defined by Loughran and McDonald (2014); *Fog Index* is 0.4*(average number of words per sentence + percent of complex words); *Flesch-Kincaid Index* is 0.39*(number of words/number of sentences) + 11.8*(number of syllables/number of words) – 15.59; *Coleman-Liau Index* is 0.0588*(average number of letters per 100 words) – 0.296*(average number of sentences per 100 words) – 15.8. *Negtone*, defined as percentage of negative words in 10-Q/K filings; *Net (Pos – Neg)* is the difference in percentage of negative and positive words in 10-Q/K filings. *Net_Pes_Sur* is the difference in percentage of net negative words in current 10-Q/K filings minus the average net negative tone in the previous 4 quarters. *Weak Modal*, defined as percentage of weak modal words in 10-Q/K filings. *Harvard IV Neg* is the list of negative words classified by Harvard Inquirer Dictionary. The other independent variables are the same as in Table 2. All the firm specific change variables represent the change in value from the previous quarter. Δ*CDS Spread,* Δ*VIX,* Δ*Rf,* Δ*TS,* and Δ*DS* represent the change in value over the event period. We include controls for industry and quarter fixed effects. The standard errors are clustered at firm level and the p-values are reported below the coefficient estimates. The sample period is from 2001 to 2016.
Statistical significance levels of 1%, 5% and 10% are indicated by ***, **, and * respectively.

**Table 7**
Alternate Event Window and Other Specifications.

| | Change in CDS Spreads $_{i,[-5,+5]}$ Alternate Window Specifications | | | | Non-Financial | Non-Crisis |
|---|---|---|---|---|---|---|
| | [-1, +1] | [-3, +3] | [-10, +10] | [0, +5] | | |
| | *(A)* | *(B)* | *(C)* | *(D)* | *(E)* | *(F)* |
| *Abtone$_{i,t}$* | 2.034** | 3.408* | 10.18** | 3.677*** | 3.962** | 6.133** |
| | (0.023) | (0.075) | (0.012) | (0.007) | (0.028) | (0.018) |
| All Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Adj R2 | 0.033 | 0.055 | 0.127 | 0.063 | 0.065 | 0.078 |
| N | 22,537 | 22,534 | 22,520 | 22,532 | 19,791 | 18,751 |

This table reports the effect of uncertain tone on 10-Q/K on the changes in CDS spreads around the event window. The dependent variable in Columns A and B is the change in five-year maturity CDS spreads from a week before the disclosure to a week after the disclosure [-5, +5]. Non-Financial firms are firms beginning with the SIC code 6. Non-Crisis period is the period of financial crisis (December 2007 to June 2009) as defined by the NBER. The other independent variables are the same as in Table 2. We include controls for industry and quarter fixed effects. The standard errors are clustered at firm level and the p-values are reported below the coefficient estimates. The sample period is from 2001 to 2016.
Statistical significance levels of 1%, 5% and 10% are indicated by ***, **, and * respectively.

re-run our analyses with a subset of periods that omits the 2007–2009 financial crisis period, when all firms moved closer to their default points, leading credit markets to react differently (Lok and Richardson 2011). We remove the crisis period from December 2007 to June 2009 from our sample data and re-run our primary regression. Column (F) of Table 7 reports the results when we exclude the financial crisis period. The coefficient of interest remains positive and statistically significant.

## Discussion & conclusion

In this study we report results suggesting that credit investors update their estimates of asset volatility in response to abnormal uncertain linguistic tone conveyed in 10-Q/K filings. We predict and find that both CDS spreads and asset volatility estimates are positively associated with abnormal uncertain tone, and additionally observe that these effects are strongest for firms with high leverage but do not vary by maturity length. We employ several conservative design features in our analysis, utilizing an event study (see Callen et al. 2009), and control also for the response implied by equity market responses to the same information. In robustness analysis, we present additional evidence suggesting that our results reflect abnormal uncertain tone rather than concurrently released financial information, other textual dimensions, or design idiosyncrasies. Taken together, these results underscore the importance of the linguistic tone of accounting disclosures, which relates to investors' assessments about firms' future credit risks through their asset volatility estimates.

Our results have implications for managers as well as regulators. Because investors pay close attention to not only the quantitative information but also to how managers express their views in the disclosures, managers should be extremely careful in articulating firm-related information. The managers can significantly reduce valuation risks by thoughtfully choosing their words. From a regulatory perspective, our results show the incremental value relevance of required qualitative information. Regulators can encourage firms to disclose more nonfinancial information that can improve the price discovery mechanism in the market. To the extent that CDS spreads reflect default risk, our results additionally suggest that managers are sensitive to and implicitly convey default uncertainties, even if they are unwilling to explicitly acknowledge going-concern risks (Mayew et al. 2015, OSC 2010). Our study also builds on textual analysis research by documenting credit market responses to uncertain tone, and demonstrating their incremental response to other textual dimensions. Lastly, our results further suggest that CDS spread changes reflect investor updating of asset volatility estimates, contributing to our understanding of the channels through which linguistic tone effects credit market responses.

Our results raise several additional questions which we leave for future research. Foremost, future research could investigate further whether uncertain tone is related to greater default frequencies, which would be useful in understanding if markets *correctly* react to uncertain tone. Relatedly, future research can also explore distinctions between *expected* tone, which can be thought of as increasing transparency in the Duffie and Lando (2001) model, versus *abnormal* tone, which can be thought of as attempts by managers to persuade rather than inform, and thus decreasing transparency. In a growing linguistic tone research space, we see a number of important research design questions, particularly around the measurement of these constructs. We encourage future research to continue to refine the measurement of linguistic attributes, which are likely considerably more complex and nuanced than the simple word dictionaries currently being used to quantify them. Lastly, we encourage future research to investigate further exactly which channels through which tone effects market responses, which could help further inform how and why credit market responses differ from equity markets.

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## Availability of Data and Material

This study utilizes data obtained from Wharton Research Data Services.

## Code Availability

Contact authors.

## Author contributions

All authors contributed equally to this manuscript.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

Data will be made available on request.

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Declarations.

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## Appendix A: Variable Descriptions

| Variable Name | Description |
|---|---|
| *CDS Spread* | CDS Spread obtained from WRDS-Markit on the day of the event (basis points) |
| *Uncertain Tone (UncTone)* | The number of Loughran-McDonald Financial-Uncertainty words in the document divided by the total number of words in the document that occur in the master dictionary (percentage) |
| *Abnormal Uncertain Tone (Abtone)* | Abnormal tone is the error term resulting from the following regression: $UncTone_{it} = \beta_0 + \beta_1 ROA_{it} + \beta_2 QRet_{it} + \beta_3 Size_{it} + \beta_4 Leverage_{it} + \beta_5 Rvol_{it} + \beta_6 \sigma ROA_{it} + \beta_7 FirmAge_{it} + \beta_8 nBsegs_{it} + \beta_9 nGEOsegs_{it} + \beta_{10} Loss_{it} + \beta_{11} \Delta ROA_{it} + \beta_{12} SUE_{it} + \beta_{13} SUEAF_{it} + timeFE + FirmFE + \varepsilon_{it}$. See also Appendix B. |
| *Asset Volatility (AssetVol)* | Estimated by fitting asset value under Merton (1974) to CDS spreads as in Kelly et al. (2019). Estimate performed for each maturity contract separately, which leads to a maturity specific implied asset volatility. |
| *Size* | Logarithm of the market value of the firm |
| *ΔSize* | Change in the market value of the firm from previous quarter |
| *Leverage* | Book Value of short-term liabilities plus long term liabilities divided by the sum of the Market Value of the firm's equity and the book value of short term plus long term liabilities. |
| *ΔLeverage* | Change in leverage of the firm from previous quarter |
| *ROA* | Net Income (NI) plus income from Extraordinary items and discontinued operations (XIDO) divided by the dollar amount of assets in the firm(AT) |
| *σROA* | standard deviation ROA over the previous 12 quarters |
| *QRet* | stock return over the previous quarter |
| *Event period equity return (EPER)* | Cumulative daily returns of the firm during the event period obtained from CRSP |
| *Realized volatility (Rvol)* | Realized volatility (annualized) of the firm's daily equity returns over the past year |
| *Credit Rating (Rate)* | Standard & Poor credit rating of a firm's debt. CR takes values of 1 to 22 with AAA being the lowest value and D being the highest value. |
| *Analyst Forecast (SUEAF)* | mean analyst forecast from IBES during the 90-day period before the disclosure of earnings |
| *Earnings Surprise (SUE)* | SUE is calculated as the actual IBES unadjusted EPS minus the mean analyst forecast during the 90-day period before the disclosure of earnings, scaled by the price per share at the end of the quarter. |
| *VIX* | Volatility Index obtained from Chicago Board Options Exchange (CBOE) |
| *Risk-free rate (Rf)* | Three-month U.S. treasury bill rate obtained from Federal Reserve Economic Data (FRED) (basis points) |
| *Term spread (TS)* | Ten-year U.S. treasury bond rate minus the three-month treasury bill rate obtained from FRED (basis points) |
| *Default Spread (DS)* | Moody's Baa Corporate bond yield relative to yield on ten-year treasury bond rate obtained from FRED (basis points) |
| $\Delta VIX_{[-5,+5]}$ | Change in VIX over the 11 day window surrounding the 10-K/10Q filing date. |
| $\Delta Rf_{[-5,+5]}$ | Change in risk free rate (Rf) over the 11 day window surrounding the 10-K/10Q filing date. |
| $\Delta TS_{[-5,+5]}$ | Change in termspread (TS) over the 11 day window surrounding the 10-K/10Q filing date. |
| $\Delta DS_{[-5,+5]}$ | Change in default spread (DS) over the 11 day window surrounding the 10-K/10Q filing date. |
| *Fog Index* | 0.4*(average number of words per sentence + percent of complex words) |
| *Flesch Kincaid* | 0.39*(number of words/number of sentences) + 11.8*(number of syllables/number of words) – 15.59 |
| *Coleman-Liau* | 0.0588*(average number of letters per 100 words) – 0.296*(average number of sentences per 100 words) – 15.8 |
| *Net_Pes_Sur* | The difference in percentage of net negative words in current 10-Q/K filings minus the average net negative tone in the previous 4 quarters. |

## Appendix B Construction of abnormal tone

| | Uncertain Tone $_{i,t}$ |
|---|---|
| $ROA_{it}$ | −0.107 |
| | (0.265) |
| $QRet_{it}$ | −0.002 |

(*continued on next page*)

(*continued*)

| Uncertain Tone $_{i,\ t}$ | |
|---|---|
| | (0.827) |
| *Size$_{it}$* | −0.119 |
| | (0.100) |
| *Leverage$_{it}$* | −0.028* |
| | (0.072) |
| *Rvol$_{it}$* | 0.658** |
| | (0.040) |
| *$\sigma$ROA$_{it}$* | −0.080 |
| | (0.657) |
| *Firm Age$_{it}$* | 0.003 |
| | (0.865) |
| *nBsegs$_{it}$* | −0.003 |
| | (0.453) |
| *nGEOsegs$_{it}$* | 0.004 |
| | (0.225) |
| *Loss$_{it}$* | 0.006 |
| | (0.424) |
| *$\Delta$ROA$_{it}$* | 0.017 |
| | (0.830) |
| *SUE$_{it}$* | 0.012 |
| | (0.561) |
| *SUEAF$_{it}$* | 0.006 |
| | (0.237) |
| Adj R2 | 0.542 |
| N | 22,609 |

This table reports the effect of various explanatory variable on the uncertainty tone used in 10-Q and 10-k statements. The dependent variable is the uncertainty tone (*UncTone*). The independent variables are various firm controls: return on assets (*ROA*); stock return over the previous quarter (*QRet*); *Size*; *Leverage*; standard deviation of return on assets (*σ ROA*); age of firm (*Firm Age*); change in return on assets (ΔROA); earnings surprise (*SUE*); realized volatility (*Rvol*), number of business segments(n*Bsets*); number of geographical segments (n*GEOsegs*); dummy variable if a firm has an earnings loss (*Loss*); earnings surprise (*SUE*) and analyst estimates (*SUEAF*). Firm fixed effects and time fixed effects are included. The standard errors are clustered at firm level and the p-values are reported below the coefficient estimates. The sample period is from 2001 to 2016.

Statistical significance levels of 1 %, 5 % and 10 % are indicated by ***, **, and * respectively.

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