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Abstract

We study how overconfident CEOs communicate with the market and whether this has implications on the firm's information environment. Textual analysis reveals that overconfident CEOs communicate using less negative tone in their 10K/Q filings. Our evidence suggests that overconfident CEOs provide market participants with more value-relevant information as sell-side analysts make more accurate forecasts of their firm's future earnings. Consistent with a reduction in asymmetric information, implied cost of equity capital is lower. However, not all investors benefit as the information advantage of short sellers disappears in the stocks of overconfident CEOs.

Keywords: Overconfident CEOs, Information Asymmetry, Cost of Capital, Short sellers

JEL Classification: D80, G14, G30

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Abstract

We study how overconfident CEOs communicate with the market and whether this has implications on the firm's information environment. Textual analysis reveals that overconfident CEOs communicate using less negative tone in their 10K/Q filings. Our evidence suggests that overconfident CEOs provide market participants with more value-relevant information as sell-side analysts make more accurate forecasts of their firm's future earnings. Consistent with a reduction in asymmetric information, implied cost of equity capital is lower. However, not all investors benefit as the information advantage of short sellers disappears in the stocks of overconfident CEOs.

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1. Introduction

The role of managerial overconfidence on corporate decision-making has received considerable attention in recent years (Malmendier and Tate, 2015). Research finds that overconfident managers adopt inefficient investment policies, pursue lower quality acquisitions, and raise the risk of security class actions lawsuits (e.g., Malmendier and Tate, 2005, 2008; Sen and Tumarkin, 2015; Banerjee, Humphery-Jenner, Nanda, and Tham, 2017). While these actions tend to hurt shareholder value, overconfidence also confers benefits. For example, overconfident CEOs are better innovators, supply greater effort, and provide better leadership to their stakeholders (e.g., Hirshleifer, Low, and Teoh, 2012; Gervais, Heaton, and Odean, 2011; Phua, Tham, and Wei, 2018).

The literature has naturally focused on corporate outcomes because managers are hired primarily to make decisions on the corporate-side. Yet, we know little about how managerial overconfidence affects outcomes on the market-side. In this paper, we hypothesize that overconfident CEOs communicate with the market differently and argue that this has implications for information asymmetry. This is an important consideration because asymmetric information has consequences on the cost of capital and company valuation (e.g., Diamond and Verrecchia, 1991; Kelly and Ljungqvist, 2012).

Using a sample of 30,149 firm-year observations in the S&P Execucomp database between 1992 and 2012, we identify overconfident CEOs by their willingness to hold deep in-the-money vested stock options. This commonly used option-based measure is based on the idea that managers who are overconfident in their firm's future prospects will voluntarily maintain excessive exposure to the idiosyncratic risk of the firm (e.g., Campbell, Gallmeyer, Johnson, Rutherford, and Stanley, 2011; Hirshleifer, Low, and Teoh, 2012).

Overconfident CEOs hold the belief that the market undervalues their company's shares (e.g., Malmendier and Tate, 2005). Intuition suggests that they are likely to expend efforts to correct this conflicting view.[1] Lively anecdotes support this claim. Elon Musk, CEO of Telsa Motors, openly tussles with skeptics on social media while Patrick M. Byrne, CEO of Overstock.com took out a full page ad in the Wall Street Journal mocking the misfortunes of cynics.[2] Theoretical models of disclosure are also support this intuition (e.g., Verrecchia, 1983; Dye, 1985). An optimistic bias can lower the threshold at which managers disclose information to the market. Consistent with this view, studies show that overconfident CEOs voluntarily release more (optimistic) earnings guidance (e.g., Hilary and Hsu, 2011; Hribar and Yang, 2015).

We start by analyzing an important disclosure event: 10K/10Q filings. Prior literature on managerial optimism examines the quantitative information in their accounting disclosure (e.g., Ahmed and Duellman, 2013). We add to this analysis by focusing on the written tone of 10K/10Q filings. Studies show that such qualitative information can be informative and supplements quantitative measures (e.g., Loughran and McDonald, 2016). We perform textual analysis of these filings (Loughran and McDonald, 2011) and find that overconfident CEOs are significantly less likely to use negative tone.[3] This difference in communication style is consistent with overconfident CEOs being optimistic and may represent an avenue of communicating '*soft*' information with the market.

The key aim of our study is to examine whether these differences in communication and disclosure by overconfident CEOs have implications on the firm's information environment.

[1] Studies suggest that managers take the information environment seriously. Survey evidence indicates that managers increase disclosure to improve the information environment (Graham, Harvey, and Rajgopal, 2005). Balakrishnan, Billings, Kelly, and Ljungqvist (2014) show that firms react to shocks to their information environment by quickly increasing disclosure to reduce information asymmetry.

[2] Overstock.com CEO mocks SAC Capital indictment in WSJ Ad. Reuters.com 2013-07-28.

[3] We focus on negative tone because a limitation of positive words is their frequent negation and hence misclassification (e.g., Loughran and McDonald, 2011; 2016).

Providing additional disclosure, all else equal, should serve to reduce information asymmetry. In practice, the outcome may be ambiguous because the information content of optimistically biased disclosure could be difficult to decipher or of marginal value-relevance. However, if rational investors take this optimism into careful consideration, investors could unwind the bias and extract the true signal (e.g., Stein, 1989). Therefore, while their disclosure may be optimistic, it may still help to reduce information asymmetry.

To assess the value-relevance of their communication and disclosure with the market, we design a test that focuses on analyst earnings forecasts. We conjecture that if disclosure is informative and value-relevant, sell-side analysts can more accurately forecast future earnings. Our evidence is consistent with this view. Overconfident CEOs are less likely to announce earnings that positively surprises the market relative to the analyst consensus forecast. Interestingly, we find no differences for negative surprise. This suggests that overconfident CEOs can effectively communicate good news and help sell-side analysts estimate more accurate earnings expectations.

If overconfidence CEOs provide disclosure and communication with the market that is more informative, we hypothesize a reduction in the differences of opinion among investors regarding firm value. Our findings support this prediction. Among the stocks of overconfident CEOs, analyst forecast dispersion is significantly lower and breadth of ownership significantly higher in stocks of overconfident CEOs relative to counterpart firms with non-overconfident CEOs.[4] This result is consistent with the Diamond and Verrecchia (1991) model that a reduction of information asymmetry can increase demand from institutional investors. The evidence also suggests that overconfident CEOs are able to generate a growing consensus among investors of their share value

[4] Diether, Malloy, and Scherbina (2002) find that analyst forecast dispersion is related to firm characteristic (e.g., high earnings variability, return volatility, and market β) that are likely to cause investor disagreement. Hong, Kubik, and Stein (2002) show that in the presence of short-sales constraints, divergence of opinion is inversely related to breadth of ownership.

and point towards a more transparent information environment.

It is worth noting that these outcomes are shaped by investor actions. Therefore, we are not simply re-documenting financial reporting choices of overconfident CEO from prior literature. Perhaps a greater challenge are systematic unobservable differences in the characteristics of firms of overconfident CEO firms. Since the results are similar using firm fixed effects, persistent fundamental firm attributes are unlikely to explain our findings.

We also recognize that overconfident CEOs may self-select or are hired into firms with a more transparent information environment. CEO-firm matching is of course still compatible with overconfidence increasing information transparency. We assess this issue more carefully by examining changes to differences of opinion around CEO turnover. If CEO-firm matching explains our findings entirely, there should be no difference in the differences of opinion after the new CEO takes over. However, the data show significant shifts in the measures of differences of opinion after changes in managerial overconfidence caused by CEO turnover. Similar patterns arise among the subset of voluntary CEO turnover events, which alleviates concerns of a common shock simultaneously affecting the information environment and causing CEO turnover. While we cannot eliminate all possible endogeneity concerns, the evidence suggests that overconfident CEO reduces investor disagreement.

A testable implication of theories of disclosure is that a reduction information asymmetry between the firm and investors can potentially reduce the cost of capital (e.g., Diamond and Verrecchia, 1991; Easley and O'Hara, 2004). Our evidence supports this theoretical prediction. Overconfident CEOs experience implied cost of equity capital (ICC) that is 34 to 74 basis points lower relative to their non-overconfident counterparts. This suggests that managerial optimism is likely to have a positive effect on equity valuation.

To better understand the nature of the information that optimistic manager disseminate, we design a test to analyze the information asymmetry *among* investors.[5] Specifically, we analyze short sellers because they are viewed as sophisticated and relatively informed. Studies show that short interest contains information on future returns (e.g., Boehmer, Jones, and Zhang, 2008; Boehmer, Huszár, and Jordan, 2010), and that short sellers gain an edge by analyzing and interpreting public information (Engelberg, Reed, and Riggenberg, 2012). Our conjecture is that if overconfident CEOs are better at communicating public information, short sellers will lose their information advantage. We test this conjecture by using short interest to form portfolios and track the performance of short sellers.

The portfolio performance tests indicate that the private information in short interest disappears among stocks with overconfident CEOs. Within stocks of overconfident CEOs, a long-short portfolio sorted by short interest in the previous month yields an insignificant Fama-French 3-factor plus momentum alpha of 0.26% per month compared to a significant alpha of 0.72% per month for stocks of non-overconfident CEOs. The inclusion of the momentum factor is important to control for past returns because the value of the CEO's options holdings are related to past returns (e.g., Hirshleifer, Low, and Teoh, 2012; Malmendier and Tate, 2015). The results are similar using the Fama-French 5-factor plus momentum factor model. The Fama-French 5-factor model also helps to address additional omitted variable concerns; it includes an investment factor to control for differences in investment decisions and investment risk. Similarly, risks associated with size, value, and profitability are also unlikely to explain this result. The findings are unchanged using independent or dependent sorts, or a matching approach based on individual firm

[5] Recent studies show that the relation between information asymmetry and cost of capital may also depend on the average precision of investor's information (e.g., Lambert, Leuz, and Verrecchia, 2012). We explore the information asymmetry among investors in this short sellers test.

characteristics. Overall, the short interest results suggests that overconfident CEOs eliminate the information advantage of short sellers and creates a 'level playing field' between informed and uninformed investors.

Our results are robust to using alternative cutoffs for the identification of overconfident CEOs or alternative measures of short interest. Firms may want to hire overconfident CEOs in good times and fire overconfident CEOs in bad times, creating additional firm-CEO matching issues when the CEO is first identified as overconfident. Following Hirshleifer, Low, and Teoh (2012), we address this concern by dropping the initial three years after a CEO is first identified as overconfident. Our results are not sensitive to this alternative specification. We also demonstrate that the financial reporting mechanisms that may release information discovered in prior literature also hold in our sample (i.e., managerial disclosure and earnings guidance (Hribar and Yang, 2015), asymmetric timeliness in the recognition of good news versus bad news (Ahmed and Duellman, 2013), and share repurchase (Banerjee, Humphery-Jenner, and Nanda, 2015). In addition to the textual analysis, this evidence provides various channels for our main findings.

Our paper contributes to the literature on CEO overconfidence. Overall, we find that managerial overconfidence reduces asymmetric information with the market. This potential "bright side" adds to the growing evidence on the benefits of managerial overconfidence.[6] The results also shed light on why boards hire or keep overconfident managers (e.g., Goel and Thakor, 2008; Gervais, Heaton, and Odean, 2011; Otto, 2014).

Our study is at the nexus of research on influence of CEO behavioral traits on market outcomes. Traditionally, research has centered on the effect of investors' behavioral biases on asset prices (e.g., Hirshleifer, 2001; Barberis and Thaler, 2003). Our study shifts the focus towards the

[6] See for example: Galasso and Simcoe (2011), Gervais, Heaton, and Odean (2011), Hirshleifer, Low, and Teoh (2012), Hilary, Hsu, Segal, and Wang (2016), Phua, Tham, and Wei (2018)

role of managers' behavioral biases on asset prices. Specifically, we focus on how managers affect the information environment. Balakrishnan et al. (2014) shows that managers are quick to respond to shocks in their information environment by increasing disclosure. Consistent with their findings, we show that the behavior trait of overconfidence affects the information environment through disclosure and communication style. Our evidence stresses the importance of behavioral CEO traits for investor demand and asset prices.

2. Data and summary statistics

This section describes the data sources and variable construction. We also report summary statistics of the sample.

2.1 Data and variables

We collect data from the following sources: 1) CEO option holdings and other CEO characteristics from the S&P Execucomp database during the period of 1992 to 2012; 2) daily and monthly stock returns, trading volume, and shares outstanding from CRSP; 3) monthly short interest and annual accounting information from Compustat; 4) stock holdings of mutual funds and institutional investors from Thomson Reuters; 5) analyst earnings forecasts from IBES; 6) CEO turnover, including both forced turnover and voluntary turnover, for all firms in the S&P ExecuComp database during the period of 1993 to 2010 from Jenter and Kanaan (2015) and Peters and Wagner (2014).[7].

To identify CEO overconfidence, we follow the most commonly used approach in the literature based on the exercise of vested CEO stock options. We only focus on the CEO's vested options because the manager is free to exercise these options. As we do not have the dataset used

[7] We thank Dirk Jenter for generously providing this data.

in Malmendier and Tate (2005, 2008), we estimate CEO overconfidence following the approach of Hirshleifer, Low, and Teoh (2012) and Campbell et al (2011). Specifically, we use the Execucomp data to construct the overconfidence measure. First, we divide the value of exercisable unexercised options (Execucomp item: opt_unex_exer_est_val) by the number of exercisable unexercised options (Execucomp item: opt_unex_exer_num) and subtract this value from the stock price at the fiscal year end (Compustat item: PRCC_F) to obtain the average strike price per option. Second, we divide the value of exercisable unexercised options per option by the average strike price per option to calculate the average moneyness of the options.

We define a CEO as overconfident once he or she postpones the exercise of vested stock options that are at least 67% in the money, following the cut-off in Malmendier and Tate (2005, 2008). The *Options67* variable takes the value of 1 if the CEO is identified as overconfident and 0 otherwise. Once a CEO is identified as overconfident, he or she remains overconfident for the rest of the sample period. Following Hirshleifer, Low, and Teoh (2012), we do not require that the CEO holds a 67% in the money option at least twice and define the CEO as overconfident after the first time he or she exhibits such a behavior. The reason is that the twice requirement encodes a look-ahead bias, which is problematic for our analysis of relation between short interest and future returns. We also construct *Options100* following the same methodology as *Options67*, except that we identify a CEO as overconfident once he or she postpones the exercise of vested options that are at least 100% in the money.

We construct two measures of differences of opinion: *analyst forecast dispersion* and *breadth of ownership*. For each firm-month, we take the standard deviation of analyst one-year EPS forecasts divided by the absolute mean forecast. We require at least five analysts to calculate the measure. Then, we calculate *analyst forecast dispersion* as the yearly average across the monthly

observations. *Breadth of ownership* by active U.S. equity mutual funds (Chen, Hong, and Stein, 2002) is calculated as the number of mutual funds holding the stock divided by the total number of mutual funds in that quarter during each firm-quarter.[8] Then, we calculate the yearly average across four quarters.

We employ two measures for the implied cost of equity capital. The Li and Mohanram (2014) measure is based on a residual income model using analysts' earnings forecasts. The Hou, van Dijk, and Zhang (2012) measure is estimated using a cross-sectional model based on past earnings history. The Appendix provides full details of the measure construction.

For a given firm-month, we define *Short Interest* as the amount of shorted shares divided by the trading volume of the month or, alternatively, divided by the total shares outstanding (Boehmer, Huszár, and Jordan, 2010). We control for the following firm characteristics. *Book Size* is the log value of book assets. *Market-to-book is* market value of assets divided by book assets. *Book Leverage is* total debt divided by book assets. *Profitability* is operating income before depreciation divided by book assets. *Sales Growth* is current year sales less prior year sales scaled by prior year sales. *Institutional Ownership* is the number of shares held by all of the institutional investors divided by the total number of shares outstanding. *Stock Return* is the cumulative stock return in a year. *Return Volatility* is the standard deviation of monthly stock returns in a year. *Trading Volume* is the average monthly trading calculated as the number of shares traded in the month divided by the total shares outstanding. The Appendix provides detailed definitions of each variable.

We also control for the following CEO characteristics. *CEO Tenure* is the logarithm of the

[8] We only focus on U.S. domestic equity mutual funds. For data from 1993 to 1999, we select funds with IOC fund objective codes (available until 1999 in the Thomson data) 2, 3, 4, and 7: Aggressive growth, Growth, Growth & Income, and Balanced. For data from 2000 to 2013, we select funds with the Lipper objective codes that pertain to domestic equity funds from the CRSP Mutual Fund database: G, SG, MC, SP, I, B, GI, FX, EI, TK, H, S, CS, UT, TL, CA, DSB, LSE, ID, BM, and CG. We use the MFLinks data to match the Thompson data with the CRSP Mutual Fund data.

number of years since the CEO resumes office. *CEO Age* is the logarithm of the CEO's age. *CEO Ownership* is the number of stocks held by the CEO divided by the number of shares outstanding. *Initial CEO* is a dummy variable that is equal to 1 if the CEO is the same CEO when the firm first appears in the Execucomp database and 0 otherwise. *Female CEO* equals 1 if the CEO if female and 0 otherwise. *Chairman CEO is* a dummy variable that is equal to 1 if the CEO is also the chairman of the board and 0 otherwise.

2.2 Summary Statistics

Table 1 reports the summary statistics of the main variables. The overall sample includes 30,149 firm-year observations during the period of 1992 to 2012. The mean value of *Options67* is 0.58, meaning that 58% of CEOs are identified as overconfident. This figure is comparable to the sample average reported in Hirshleifer, Low, and Teoh (2012). The alternative measure *Options100* has a mean of 0.46. After merging with firm characteristics and other CEO characteristics, the combined sample includes 28,086 firm-year observations. Consistent with the fact that Execucomp firms are relatively large, the mean and median size of book assets is $13.8 billion and $1.7 billion respectively, The average CEO tenure is 7.8 years and the average CEO age is 56 years. Around 56% of the CEOs serve as the chairman of the board, 2% are female CEOs, and the average CEO stock ownership is 1.8% of the firm's shares outstanding.

Table II reports the percentage of overconfident CEOs year by year. In each year from 1992 to 2012, we report the mean and standard deviation of two CEO overconfidence measures, *Options67* and *Options100.* The time-series pattern shows that CEOs tend to become more overconfident during market booms and less so during market downturns, consistent with Hirshleifer, Low, and Teoh (2012).[9]

[9] This may raise firm-CEO matching issues that CEO overconfidence can be spuriously correlated with market

3. Overconfident CEOs and tone of communication

We begin our analysis by investigating how overconfident CEOs might communicate differently with the market. Prior literature shows that overconfident CEOs provide more optimistic disclosure through the release of management earnings forecasts (e.g., Hilary and Hsu, 2011; Hribar and Yang, 2015).[10] We complement these findings by analyzing the qualitative information content of their 10K/10Q filings. Specifically, we analyze the tone of these filings using the textual classification of financial words developed in Loughran and McDonald (2011). Studies show that such qualitative information is potentially informative and supplements quantitative measures (e.g., Loughran and McDonald, 2016).

We examine the effect of CEO overconfidence on tone by estimating specification (1):

$$Negative/positive\ tone_{i,t} = \alpha + \beta \times Overconfident\ CEO_{i,t-1} + \delta \times X_{i,t-1} + \varepsilon_{i,t} \quad (1)$$

Overconfident CEO is the *Options67* measure and *negative/positive tone* is measured using negative or positive tone which is the Loughran-McDonald negative/positive word proportion, defined as the number of Loughran-McDonald Financial-Positive (Negative) words divided by the total number of words in the document that occur in the master dictionary. We also include a control for *word count*, which is the total number of words in the filing. $X_{i,t-1}$ represents firm characteristics including book size, market-to-book, book leverage, profitability, sales growth, institutional ownership, return volatility, and trading volume. Following Hirshleifer, Low, and Teoh (2012) and Malmendier and Tate (2015), we control for past stock returns. All specifications include year fixed effects to capture time-varying macroeconomic shocks. We cluster standard errors by firm.

conditions. It could be that firms tend to hire overconfident CEOs in good times and fire overconfident CEOs in bad times. Following Hirshleifer, Low, and Teoh (2012), we address this concern by dropping the first three years since a CEO starts to be identified as overconfident. We report these results in later analyses.

[10] In Section 6, we verify that these patterns of disclosure by overconfident CEOs also occur in our sample.

Table III shows that overconfident CEOs use significantly less negative tone for both 10K (Panel A) and 10Q (Panel B) filings. The results are similar with the inclusion of firm fixed effects in column 2. However, columns 3 and 4 show no statistical difference in the usage of positive tone between overconfident and non-overconfident CEOs. One potential explanation for this latter result is the frequent negation of positive words, which may cause mis-classification (e.g., Loughran and McDonald, 2016). The results are also interesting because Loughran and McDonald (2011) find suggestive evidence that the usage of negative tone appears to cause equity analysts to overreact; managers using more negative tone tend to beat analyst forecast at the next earnings announcement.

4. CEO overconfidence, investors beliefs, and the cost of capital

The main focus of our paper is whether the difference in corporate communication of overconfident CEOs has implications on the information environment. In this section we focus on the transmission of information to the market and investor beliefs. First, we examine the effects on analyst earnings forecast surprise and differences of opinion. Then, we analyze the cost of capital.

4.1 CEO overconfidence and analyst earnings forecast surprise

We examine the effect of CEO overconfidence on forecast error by estimating specification (2):

$$Positive/negative\ forecast\ error_{i,t} = \alpha + \beta \times Overconfident\ CEO_{i,t-1} + \delta \times X_{i,t-1} + \varepsilon_{i,t} \qquad (2)$$

Overconfident CEO is the *Options67* measure and *positive/negative forecast error* is an indicator variable taking a value of one if the firm's earnings surprise is above the top/bottom tercile in the sample year and zero otherwise. The earnings surprise is calculated as the difference between the actual earning minus the analyst consensus divided by the stock price before the

announcement date. $X_{i,t-1}$ represents the same set of firm characteristics used in equation 1. All specifications include year fixed effects to capture time-varying macroeconomic shocks. We cluster standard errors by firm.

The results in Table IV support this conjecture. The logit regression in column 1 shows that overconfident CEOs are less likely to announce positively earnings surprise (relative to analyst forecasts). The inference is similar using a conditional logit regression in column 2. Columns 3 and 4 show no difference among negative earnings surprise using either the logit or conditional logit models. This evidence suggests that overconfident CEOs may effectively communicate with the market through the usage of tone in their 10K/10Q filings. It suggests that they are better able to communicate good news to sell-side analysts, which helps manage more accurate earnings expectations. Although we cannot observe all possible communication between management and analysts, this finding suggests that overconfident CEOs are able to influence the views of this important group of market participants.

4.2 CEO overconfidence and differences of opinion

We conjecture that if managerial overconfidence disseminate value-relevant information, this should also reduce the differences in opinion among investors. We examine the impact of overconfident CEOs on differences of opinion by estimating specification (3):

$$\textit{Difference of opinion}_{i,t} = \alpha + \beta \times \textit{Overconfident CEO}_{i,t-1} + \delta \times X_{i,t-1} + \varepsilon_{i,t} \quad (3)$$

Overconfident CEO is the *Options67* measure of overconfidence. *Difference of opinion* is measured using either analyst forecast dispersion (e.g., Diether, Malloy, and Scherbina, 2002) or breadth of mutual fund ownership (e.g., Hong, Kubik, and Stein, 2002). Diether, Malloy, and Scherbina (2002) find that analyst forecast dispersion is related to firm characteristic (e.g., high

earnings variability, return volatility, and market β) that are likely to cause investor disagreement. Hong, Kubik, and Stein (2002) show that in the presence of short-sales constraints, divergence of opinion is inversely related to breadth of ownership. $X_{i,t-1}$ represents the same set of firm characteristics used in the prior regression. All specifications include year fixed effects to capture time-varying macroeconomic shocks. We cluster standard errors by firm.

Panel A of Table V shows a significantly negative relation between CEO overconfidence and analyst forecast dispersion. The parameter estimate in Column (1) indicates a 2.6% (t-stat=-5.82) decrease in analyst forecast dispersion for stocks of overconfident CEO. The inclusion of industry fixed effects in Column (2) does not change our conclusions (2.5%, t-stat=-5.83). Column (3) shows that the inferences are also similar after controlling for the following CEO characteristics: CEO tenure, age, ownership, founder, chairman, and female indicators. To capture unobserved firm heterogeneity, we estimate a specification with firm fixed effects in Column (4). The results remain similar, suggesting that unobserved firm heterogeneity is not behind the findings.

Consistent with the view that forecast dispersion captures investor disagreement, we find that analyst forecast dispersion is associated with greater return volatility and higher trading volume. Analyst forecast dispersion is also associated with firm leverage, smaller firm size, lower profitability, and lower past stock returns (e.g., Garfinkel, 2009).

Since analysts are not direct buy-side investors, we use an investor-based measure that captures the breadth of ownership by active U.S. equity mutual funds (e.g., Chen, Hong, and Stein, 2002). Diamond and Verrecchia (1991) show that a reduction of information asymmetry can increase demand from institutional investors, which leads to higher breadth of ownership.

Panel B of Table V shows that CEO overconfidence increases the breadth of ownership. In Column (3), the parameter estimate suggests that firms with overconfident CEOs display a 22.3%

(t-stat=3.71) higher breadth of ownership relative to the sample average. Column (4) reports similar results with firm fixed effects (39.2%, t-stat=7.71). Firm size, market-to-book, profitability, institutional ownership, and past stock return are positively related to breadth of ownership, while trading volume, book leverage, and CEO ownership are negatively related to breadth of ownership. These estimates are consistent with the view that breadth of ownership captures investor disagreement.

4.3 Changes in investor beliefs around CEO turnover

While our findings are consistent with managerial overconfidence reducing information asymmetry, simultaneity and reverse causality may confound our interpretation. Including firm fixed effects in our specifications alleviates some endogeneity concerns. Still, we recognize that overconfident CEOs may self-select or are hired into firms with lower information asymmetry. To address this issue, we examine changes in information asymmetry around CEO turnover similar to Ahmed and Duellman (2013). If CEO-firm matching explains our findings, we expect no change to the information asymmetry measures after a new CEO is appointed.

We obtain the data on CEO turnover for all firms in the S&P Execucomp database during the period of 1993 to 2010 from Jenter and Kanaan (2015). We examine information asymmetry in the two years prior to the turnover year, the turnover year, and two years after the turnover year. We start with 1645 CEO turnover events (336 forced turnovers and 1309 voluntary turnovers). To ensure the validity of the tests, we require that there is only one CEO change during the five-year period. This filters the sample to 814 turnover events (73 forced turnovers and 741 voluntary turnovers). Then, we calculate the average values of investor disagreement and the control variables in the two years after the CEO change and subtract the average values of the corresponding variable during the two years prior to the CEO change. We skip the turnover year

to avoid potential confounding effects.

Table VI presents evidence of significant shifts in the difference of opinion measures after changes in CEO overconfidence due to turnover. Panel A includes all of the CEO turnover events. Changes in managerial overconfidence due to CEO turnover are negatively related to changes in analyst forecast dispersion and positively related to changes in breadth of ownership. These results suggest that investor disagreement increases when an overconfident CEO is replaced by a non-overconfident CEO and decreases when a non-overconfident CEO is replaced by an overconfident CEO.

One remaining concern is that poor recent stock performance may simultaneously increase investor disagreement and cause overconfident CEOs to be fired. To side-step this issue, we focus only on voluntary CEO turnover. Panel B shows that the results are similar using only voluntary CEO turnover.

4.4 CEO overconfidence and the cost of capital

Diamond and Verrechia (1991) and Easley and O'hara (2004) show a connection between the information environment and the cost of capital. To examine the effect of overconfident CEOs on the cost of equity capital, we estimate specification (4):

$$ICC_{i,t} = \alpha + \beta \times Overconfident\ CEO_{i,t-1} + \delta \times X_{i,t-1} + \varepsilon_{i,t} \quad (4)$$

Implied cost of capital *(ICC)* is measured using either a residual income model method (Li and Mohanram, 2014) or a firm fundamentals method (Hou, Van Dijk, and Zhang, 2012). $X_{i,t-1}$ represents firm characteristics including book size, market-to-book, book leverage, profitability, sales growth, institutional ownership, return volatility, and trading volume. All specifications

include year fixed effects to capture time-varying macroeconomic shocks. We cluster standard errors by firm.

Table VII shows that overconfident CEOs experience significantly lower implied cost of capital. Column (1) of Panel A shows that the ICC of an overconfident CEO is 77 basis points lower after conditioning on firm characteristics using the Li and Mohanram (2014) model. The results are unchanged with the inclusion of industry fixed effects in Column (2), measures of CEO characteristics in Column (3), or firm fixed effects in Column (4). Column (1) of Panel B shows that the ICC of an overconfident CEO is 40 basis points based on the Hou, Van Dijk, and Zhang (2012) measure. The next three columns shows similar results with the inclusion of industry fixed effects (34 basis points), measures of CEO characteristics (38 basis points), or firm fixed effects (45 basis points). Overall, the results are consistent with the implication that improvements in the information environment lowers the cost of capital.

5. Overconfident CEOs and short sellers

To better understand the nature of the information that optimistic manager disseminate, we analyze the information asymmetry *among* investors.[11] The evidence in previous sections is consistent with the view that overconfident CEOs communicate more value relevant information. However, this information may not necessarily benefit all investors. For example, overconfident CEOs may create a "level playing field" by releasing private information that marginalizes the information advantage of certain informed traders

We create a test that examines short sellers because they are widely considered to be sophisticated and relatively informed. Short-selling is risky, costly, and requires superior

[11] Recent studies show that the relation between information asymmetry and cost of capital may also depend on the average precision of investor's information (e.g., Lambert, Leuz, and Verrecchia, 2012). We explore the information asymmetry among investors in this short sellers test.

information. Short seller's trading activities are publically available through short interest. Studies show that short interest contains information about future abnormal returns (e.g., Boehmer, Jones, and Zhang, 2008; Boehmer, Huszár, and Jordan, 2010). Engelberg, Reed, and Riggenberg (2012) find that short sellers gain an advantage by analyzing and interpreting public information. Our conjecture is that if overconfident CEOs are better at communicating public information, the information advantage of short sellers is reduced. For our test setting, we adopt the short interest setting in Boehmer, Huszár, and Jordan (2010) (henceforth BHJ 2010).

5.1 Verifying the information content of short interest in our sample

Since the BHJ 2010 sample ends in 2005, we first establish that their main findings hold in our sample. We extend their original time period by eight years (until 2013) and focus on the stocks in the S&P Execucomp database (S&P 1500). Each month-beginning from January 1993 to December 2013, we sort stocks into quintiles based on the previous month-end short interest. Following BHJ 2010, short interest is defined as the amount of shorted shares divided by the trading volume of the month, and we focus on equally-weighted returns. Portfolio 1(5) has the lowest (highest) short interest. "Long Portfolio 1 & Short Portfolio 5" is the difference in the returns between the lowest and highest short interest portfolios. For all the portfolios, we report the raw average return, the alpha from the Fama-French 3-factor model, and the alpha from Fama-French 5-factor model. We add the momentum factor to the Fama-French models because, as noted in prior literature, the *Options67* measure embed past returns (e.g., Hirshleifer, Low, and Teoh, 2012; Malmendier and Tate, 2015).

Panel A1 of Table VIII shows that short interest predicts future returns in our sample. The long-short portfolio yields a significant alpha of 0.48% (0.51%) per month using the 3-factor plus momentum model (5-factor plus momentum model). Consistent with BHJ 2010, this is driven

mostly by the positive alpha in the lowest short interest portfolio. Panel A2 reports for each portfolio the mean and standard deviation of short interest and the percentage of overconfident CEOs. A CEO is identified to be overconfident if the indicator variable *Options67* is equal to one in the previous year. Notably, the average percentage of firms with overconfident CEOs is similar across the five portfolios, being 54.1% in Portfolio 1 and 56.7% in Portfolio 5.

5.2 CEO overconfidence and the information content of short interest

The results in Panel B show that the return predictability in short interest is nearly non-existent among stocks with overconfident CEOs, but significant among stocks with non-overconfident CEOs. Panel B1 shows that the long-short portfolio alpha is statistically insignificant in both specifications. Panel B2 shows that for the non-overconfident sample of firms, the long-short portfolio is positive and statistically significant across both specifications. Panel C shows that the difference between overconfident and non-overconfident CEOs (Panel B1 minus Panel B2) is statistically different. We also find that this difference is statistically different using dependent sorting. Overall, the results provide suggestive evidence that overconfident CEOs disseminate information that levels the playing field among investors.

5.3 Robustness test: Alternative measure of short interest

Our results are also robust to scaling short interest by total shares outstanding. Panel A of Table IX shows that the independently sorted long-short portfolio yields an alpha of 0.36% per month (t-stat=1.80) for overconfident CEOs, compared to a significant alpha of 0.69% per month (t-stat =3.53) for non-overconfident CEOs based on the Fama-French 5-factor plus momentum factor model.

6. Addressing alternative explanations and additional discussions

We address alternative explanation and provide additional discussions in this section. First, we perform our main tests using a higher cutoff to measure overconfidence, *Options100*. Next, we examine whether CEO option characteristics affect our findings. We also provide an additional test to further address the CEO-firm matching issue. Lastly, we verify the disclosure channels documented in prior literature.

6.1 Measurement of overconfidence

We use a more conservation cutoff, the indicator variable *Options100,* as an alternative measure to identify overconfident CEOs. This insures that we are not incorrectly classifying overconfident CEOs due to randomness in option valuation. From Table I, the *Options100* variable has a mean of 0.46, implying that 46% of CEOs are identified as overconfident. We repeat our key regressions using *Options100* and report the results in Table XI. Panel A reports the relation between CEO overconfidence (*Options100*) and measures of differences of opinion. In Panel B, we sort stocks into portfolios by short interest among overconfident CEOs and among non-overconfident CEOs. Portfolio 1 (5) has the lowest (highest) short interest. "Long Portfolio 1 & Short Portfolio 5" is the difference in the returns between Portfolio 1 and Portfolio 5. For brevity, we only report the results for Portfolio 1, Portfolio 5, and the Long-Short portfolio.

Consistent with our earlier findings, overconfident CEOs, as measured with *Options100*, are associated with lower analyst forecast dispersion and higher breadth of ownership. The patterns are similar across our main portfolio sorts. Using a Fama-French 5-factor plus momentum factor model, in the case of independent sorting (Panel A), the long-short portfolio yields an insignificant alpha of 0.19% per month (t-stat=0.89) for overconfident CEOs, compared to a significant alpha of 0.69% per month (t-stat=4.13) for non-overconfident CEOs. Similarly, in the case of dependent sorting, the long-short portfolio yields an insignificant alpha of 0.27% per month (t-stat=0.97) for

overconfident CEOs, compared to a significant alpha of 0.69% (t-stat=4.09) per month for non-overconfident CEOs.

We also perform all of our main tests using the requirement that the CEO holds a 67% in the money option at least twice over the past five years. Our findings are similar using this definition (unreported to save space).

It is reasonable to ask whether our results hold using other measures of CEO overconfidence. However, we are unable to use other measures of CEO overconfidence due to nature of our empirical tests. For example, Kolasinski and Li (2014) propose a measure of overconfidence based on CEOs who lose money on trades in their company stock. This forward-looking nature of this measure would mechanically correlated with the future returns we study in the short interest tests. Studies have also proposed a press-based measure (e.g., Malmendier and Tate, 2005; Hirschleifer, Low, and Teoh, 2012; Hribar and Yang, 2015) or guidance-based measure (e.g., Otto, 2014). These measures also causes issues with our tests because media appearances and voluntary guidance directly affect the information environment and would likely confound our statistical inferences.

6.2 CEO options delta and vega

Overconfident CEOs tend to have higher values of options delta and vega (e.g., Hirshleifer, Low, and Teoh, 2012). Also, Coles, Daniel, and Naveen (2006) find that pay for performance sensitivity (delta) and sensitivity of CEO wealth to stock volatility (vega) affect investment and risk taking behavior. Therefore, CEO options sensitivity is a potential omitted variable that may explain our findings. To address this issue, we include controls for delta and vega in our main tests. The values for delta and vega are from Lalitha Naveen's website which follows the calculations established in Core and Guay (2002). Our results are unchanged after including these controls.

6.3 Matching between overconfident CEOs and companies

We address the potential concern that CEOs may be hired for their overconfidence. Therefore, we drop the initial three years once the CEO is identified as overconfident. For this test, we use the Options67 measure and perform the analysis from 1996 to 2012 due to data limitations. Under this specification, the percentage of overconfident CEOs is relatively stable across different years, with an average percentage of 45%.

In Panel A, we repeat the analyses in Table V and Table VII on the relation between CEO overconfidence and measures of differences of opinion and implied cost of equity capital. In Panel B, we repeat the analyses in Table VIII and sort stocks into portfolios by short interest among overconfident CEOs and among non-overconfident CEOs. Portfolio 1 (5) has the lowest (highest) short interest. "Long Portfolio 1 & Short Portfolio 5" is the difference in the returns between Portfolio 1 and Portfolio 5. For brevity, we only report the results for Portfolio 1, Portfolio 5, and the Long-Short portfolio.

The evidence is consistent with our main analysis. Overconfident CEOs are associated with lower analyst forecast dispersion, higher breadth of ownership, and lower cost of capital. We also continue to observe similar patterns across our main portfolio sorts.

6.4 Verifying the relation between CEO overconfidence and information disclosure

We verify that prior findings on the relation between CEO overconfidence and information disclosure hold in our sample. In the Internet Appendix, we show that CEO overconfidence is associated with greater managerial disclosure (Hribar and Yang, 2015), asymmetric timeliness in the recognition of good news versus bad news (Ahmed and Duellman, 2013), and share repurchase (Banerjee, Humphery-Jenner, and Nanda, 2015).

6.5 Alternative benchmarking for short interest portfolios

A concern with the short interest portfolio sorts is that factor models do not capture all firm

characteristics. Therefore, we perform one-on-one matching (with replacement) between stocks of overconfident CEOs with non-overconfident CEOs. While matching is traditionally performed among a group of characteristics (propensity-score matching), we perform individual characteristic matching to isolate the possibility that a particular characteristic may behind our findings. As we discuss in the online appendix, we are particularly concerned with the role of past stock returns. Importantly, we find similar results using a propensity-score match using all eight characteristics together. These results are available upon request. We find similar results using this matching analysis. The full set of results along with descriptions are available in the online appendix.

6.6 Could information transparency create CEO overconfidence?

A potential reverse causality story is that improvements in the information environment may cause CEOs to be overconfident. A plausible story might be that information transparency coincides with good stock performance and creates managerial optimism. There are at least four reasons why we believe this an unlikely explanation for our findings. First, overconfidence is generally viewed as a stable personality trait both in the finance and psychology literature. Our empirical analysis uses a forward-looking measure of CEO overconfidence for asset pricing analysis, but our short interest results are even stronger (perhaps unsurprisingly) using the standard backwards looking measure of CEO overconfidence which treats overconfidence as a stable personality trait.

Second, our information asymmetry tests include firm fixed effects. This suggests that persistent firm characteristics (such as firms with high information transparency) are unlikely to explain our findings. Further, the analysis in Section 3.3 on CEO turnover suggests that information asymmetry is relates only to the optimism of the CEO in office, but not prior CEO. Fourth, the matching results based on past returns suggest that the short interest findings are not

due to past returns.

7. Conclusion

Managerial overconfidence has attracted significant research attention in recent years (Malmendier and Tate, 2015). While past studies focus on the corporate decisions of overconfident CEOs, we turn the attention to the effects on the market side. We contribute to the existing evidence on how overconfident CEOs communicate with the market by showing that they use less negative tone in the 10K/Q filings.

We argue that these differences in corporate communication have implications on information asymmetry. We find that analysts can generate more accurate forecasts of earnings expectations. Investors have relatively lower differences of opinion of stocks of overconfident CEOs. Such evidence is consistent with greater information transparency. Consistent with theoretical predictions, implied cost of equity capital is reduced in firms of overconfident CEOs.

However, we find that not all investors benefit from greater information transparency. While short interest is informative of future returns in the overall sample, short interest does not predicts higher future returns among stocks with overconfident CEOs. The evidence is consistent with the view that overconfident CEOs marginalize the information advantages of short sellers.

Our results have broader implications on behavioral finance and market efficiency. Traditionally, research has centered on the effect of investors' behavioral biases on asset prices (e.g., Hirshleifer, 2001; Barberis and Thaler, 2003). Our study shifts the focus towards the role of managers' behavioral biases on asset prices. Our results are somewhat surprising in that CEO overconfidence may help increase valuation (i.e., lower the cost of capital and reduce under-valuation). The additional implication that boards may optimally hire overconfident CEOs when the company enjoys greater gains from lower information asymmetry. Our evidence suggests that

behavioral CEO traits influence investor behavior and asset prices.

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