Optimism or Over-Precision? What Drives the Role of Overconfidence in Managerial Decisions?

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Abstract

Overconfidence has two dimensions: over-optimism and over-precision. Extant empirical studies focus mostly on the former due to the difficulty in measuring the latter. This study disentangles these two dimensions through a novel exploitation of earnings forecasts issued by managers. The resulting two overconfidence measures capture different aspects of the link between overconfidence and managerial decisions. In terms of investment, CEOs displaying excess precision are more likely to scale up investment in real assets (especially via M&A); firms with optimistic CEOs display no such proclivity. On the financing side, optimistic and overly precise CEOs share a higher propensity to issue debt.

Keywords: Overconfidence, Optimism, Over-Precision, Miscalibration, Corporate Investment, Corporate Financing

JEL Code: G31, G32 & G34

1. Introduction

Overconfidence is a common behavioral bias in humans, and its significance to the conduct of human affairs is difficult to overstate (Griffin and Tversky, 1992). The psychology literature describes overconfidence as manifested in two main flavors: (1) positive illusion (or over-optimism) and (2) over-precision of beliefs (Skala, 2008). In a nutshell, over-optimism is a 'better than average' effect, while over-precision bias is "an unwarranted belief in the correctness of one's answers" (Koriat, Lichtenstein, and Fischhoff, 1980). The former can be thought of as overconfidence regarding the mean (i.e., the first moment), and the latter as overconfidence regarding the precision (i.e., the second moment – variance effect).[1]

Broadly speaking, the finance literature on CEO overconfidence has examined the over-optimism aspect carefully but has developed relatively little understanding about over-precision.[2] For example, CEO overconfidence is widely entertained as an important driver behind a wide range of corporate finance policies (e.g., Malmendier and Tate 2008; Hirshleifer, Low, and Teoh 2012; Ben-David, Graham, and Harvey 2013). However, the existing literature primarily focuses on optimism, while largely remaining silent on the role of *over-precision bias*. In this paper, we put under the microscope the relative importance of this largely neglected aspect of overconfidence (i.e., over-precision) in the context of corporate financial decision making.

[1] Positive illusion refers to the better-than-average effect and unrealistic optimism. Many experimental studies in the psychology literature have shown that individuals have a tendency to consider themselves "above average" and are too optimistic about their own future prospects (Alicke et al. 1995; Svenson 1981; Weinstein 1980). For example, Svenson (1981) finds that 77% of subjects rate their driving skills as safer than average, and 69% consider themselves to be more skillful. People have also been found to believe that favorable future life events are more likely to happen to them, with less chance for negative events (Weinstein 1980). Camerer and Lovallo (1999) find that positive illusion also appears in economic decision-making experiments. They find that potential business founders predict their own profit to be positive, although they recognize that the majority of new businesses fail.

[2] As noted by Skala (2008), overconfidence and optimism are often used interchangeably for this type of overconfidence in the behavioral corporate finance literature. For example, Malmendier and Tate (2005, 2008) refer to the overestimation of future firm performance as overconfidence, while Otto (2014) refers to it as optimism. Throughout this study, we use optimism to refer to the mean (or first moment) effect of overconfidence.

Over-precision arises when economic agents have subjective probability distributions that are too narrow. They either overestimate the precision of their information or underestimate the variance of random events. For example, Fischhoff, Slovic, and Lichtenstein (1977) show that when answering questions, experiment participants generally assign a much higher accuracy rate than the actual probability. Similarly, Ben-David, Graham, and Harvey (2013) show that CFOs provide forecast intervals for future S&P 500 returns that are too narrow. Throughout this study, we use the term "over-precision" to represent this second moment type of overconfidence.

It is important to understand the relative importance of over-precision bias versus over-optimism in corporate finance for at least two reasons. First, in surveying the literature on overconfidence, Moore and Healy (2008) note that "*[t]here are three notable problems with research on overconfidence. The first is that the most popular research paradigm confounds overestimation with overprecision" (p. 503).*[3] As they point out, this issue permeates beyond the psychology literature, and affects the empirical research on overconfidence in behavioral finance and economics literature. Second, Moore and Healy (2008) find that over-precision is more persistent than over-optimism. Moreover, over-precision reduces the effect of over-optimism in an experimental setting, suggesting that over-precision have a first order importance in decision making processes.

Theoretical models in the behavioral corporate finance literature generally differentiate between over-optimism and over-precision. The former is often modelled as an overestimation of the firm's cash flows (e.g., Heaton, 2002; Malmendier and Tate 2005; Hackbarth 2008). Over-precision is usually defined as an underestimation of risk (e.g., Ben-David, Graham, and Harvey

[3] The other two (out of three) problems with research on overconfidence are (1) the prevalence of underconfidence, and (2) the inconsistency between overestimation and overplacement. In this study, we only focus on the first problem identified in Moore and Healy (2008).

2013; Hackbarth 2008).[4] While defining theoretical constructs of managerial overconfidence and its distinct components is relatively simple, identifying reliable proxies for such constructs is a major challenge for empirical studies.

In the existing empirical literature, the most widely used proxy for managerial overconfidence is an option-based measure developed by Malmendier and Tate (2005, 2008). CEOs who hold on to deeply in-the-money options beyond a reasonable threshold are classified as overconfident because they are *over-optimistic* about future firm performance. However, Malmendier and Tate (2005) also discuss how this proxy can have the opposite relation with the second aspect of overconfidence: over-precision. CEOs who overestimate the precision of their signals are likely to have lower estimates of the firm's stock volatility and therefore lower values of holding the firm's stock options. Nevertheless, the option-based proxy is sometimes also used to measure over-precision as it is difficult to capture over-precision using any other available measures. In this study, we confront this empirical challenge by using earnings forecasts issued by management, which allows us to disentangle over-precision from over-optimism. This provides an avenue to directly examine the effect of over-precision on corporate policies, and how it can be distinct from over-optimism.

Management earnings forecasts are useful in this context for three reasons. First, if executives are optimistic, they believe that the firm's future performance will be better than its later actual realization, and would issue forecasts that are more optimistic than behaviorally neutral alternative forecasts. Second, the vast majority of management earnings forecasts (i.e., 90%) are presented in the form of a range, which provides sufficient information to simultaneously deduce a measure of over-precision. Our intuition is simple: executives who

[4] Online Appendix A provides a summary of various definitions of overconfidence used in both psychology and behavioral finance literatures.

underestimate the distribution of potential future outcomes would be more likely to provide narrower forecast ranges.

Third, we are aware of two empirical studies that have established a link between earnings forecasts and CEO overconfidence, which encourage a deeper dive into this fruitful setting. In an experimental setting, Libby and Rennekamp (2012) find that overconfident participants are more likely to forecast better subsequent performance (when compared to less confident participants). Using both option-based and press-based measures of CEO overconfidence, Hribar and Yang (2016) find that overconfident CEOs are more likely to issue more optimistic earnings forecasts. They also find that CEOs who hold on to deep-in-the-money options also display over-precision. The latter result is inconsistent with the motivation for the option-based measure as discussed in Malmendier and Tate (2005, p.2671).

To the best of our knowledge, Ben-David, Graham, and Harvey (2013) is the first study that empirically examines the effect of over-precision on corporate investment and financial leverage.[5] Utilizing confidence intervals on S&P 500 return predictions provided in their CFO survey, Ben-David, Graham, and Harvey (2013) attempt to differentiate between optimism and over-precision. They find the CFOs in their survey to be severely 'miscalibrated', as only 36.3% of one-year S&P 500 returns fall within the CFOs' 80% confidence interval. Ben-David, Graham, and Harvey (2013) also provide some preliminary results suggesting that miscalibrated managers invest more and tolerate higher financial leverage.

While our study extends on Ben-David, Graham, and Harvey (2013), these two studies differ in the following four respects. *First*, as opposed to the private nature of their surveys, our

[5] We consider the empirical results from Ben-David, Graham, and Harvey (2007) to be superseded by Ben-David, Graham, and Harvey (2013). However, we also refer to Ben-David, Graham, and Harvey (2007) for the theoretical model and the empirical predictions on miscalibration, which is their preferred term for over-precision. While we use both terms interchangeably in this paper, we lay out our hypotheses and empirical results using "over-precision". We use the miscalibration term as appropriate when discussing existing studies.

measures of overconfidence – from earnings forecasts issued by management – can be publicly observed by market participants as well as researchers, and therefore can be more easily adopted by future empirical studies. *Second*, our study covers a larger sample of firms, which allows us to develop more robust inferences. *Third*, the larger sample also enables us to examine the investment decisions of overconfident CEOs in greater detail and to identify the channels through which overconfidence is related to firm investment decisions. *Fourth*, we provide further evidence on the impact of both over-optimism and over-precision on corporate financing decisions.

In this study, we collect annual management earnings forecast data from the IBES *Guidance* database. Our sample covers the period from 2001 to 2014. Qualitative and open-ended forecasts are excluded, as they are not amenable to the measure we propose. In total, we have 20,300 management earnings forecasts to derive the overconfidence measures. These earnings forecasts can be affected by various firm characteristics and managerial incentives. As a result, we partial out a range of possible confounding effects through a regression design and use the residuals to measure the two facets of overconfidence. Following Cheng and Lo (2006) who argue that the firm's CEO has the greatest influence over a wide range of corporate decisions, including earnings disclosure decisions, we attribute our measures of overconfidence to CEOs rather than firms.[6]

Generally, we find that the CEOs in our sample are overly precise in their earnings forecasts. CEOs who are not prone to over-precision bias are expected to provide a range of earnings forecasts with a relatively high confidence level. However, contrary to this expectation, 67.0% of actual earnings fall outside the forecast range, suggesting that CEOs generally

[6] Consistent with modeling overconfidence as a personal fixed effect, we observe that the overconfidence measures we develop display persistence over time. Attributing overconfidence at the CEO level is also consistent with the finding in Bertrand and Schoar (2003) that managerial style matters even after controlling for firm heterogeneity.

underestimate the distribution of potential outcomes. For CEOs who are classified as overly precise, the percentage of actual earnings that fall outside of the range is even higher: 71.3%, suggesting that our measure of over-precision successfully captures the underestimation of risk rather than better forecasting skills.[7]

We then turn to examine how optimistic and overly precise CEOs are different in their corporate investment decisions. We hypothesize that both optimistic and overly precise CEOs would invest more, as they either overestimate project cash flows or use a lower discount rate (underestimate risk) that may turn potential projects with negative NPVs into seemingly positive ones. Overly precise CEOs in our sample invest more in real assets, while optimistic CEOs do not display such pattern. We further document that the increase in investment by overly precise CEOs is mainly driven by external acquisitions. This finding is affirmed using merger and acquisition (M&A) transaction data from the Thomson SDC database. Specifically, overly precise CEOs are more likely to engage in acquisitions, in particular those with targets in different industries.

We argue that both optimistic and overly precise CEOs believe external risky securities to be undervalued by the capital market, as they either over-forecast the cash flows of the firm (optimistic) or use a lower discount rate than the market does (overly precise). Because equity prices are particularly sensitive to biases in belief, we hypothesize that overconfident CEOs would avoid these securities and instead issue more debt to finance their investments. Using a sample of security issuances for the period between 2001 and 2014, we find that overly precise CEOs are more likely to issue debt. This pattern remains even after controlling for a sample selection issue. Unlike overly precise CEOs, optimistic CEOs are more likely to issue hybrid

[7] Our finding that managers tend to be overly precise in general is consistent with Goel and Thakor (2008). They argue that overconfident managers who underestimate risk and take on excessive risk that results in overrepresentation of the right-tail winners are more likely to be promoted.

securities such as convertible debts and convertible preferred shares. These distinct patterns again highlight the importance of examining these two aspects of overconfidence separately.

Our study provides three contributions to the existing behavioral corporate finance literature. First, and most importantly, we develop a new set of proxies for overconfidence based on management earnings forecasts that distinguish over-precision from optimism. This approach will help to advance empirical analysis on managerial over-precision, which is linked to a wide range of corporate decisions in various existing theoretical models (e.g., Hackbarth 2008; Gervais, Heaton, and Odean 2011). Second, supplementing existing findings that CEO optimism plays an important role in investment decisions (e.g., Malmendier and Tate 2005, 2008), we document that CEO over-precision plays an at least equally important role, especially in acquisition decisions. Our findings suggest that ignoring the distinction between these two facets of overconfidence may lead to inaccurate conclusions. Third, this study provides empirical evidence for the role of CEO over-precision in corporate financing decisions. Specifically, firms with overly precise CEOs are more likely to issue debt than otherwise similar firms whose CEOs are not as precise.

The remainder of this study proceeds as follows. We develop the hypotheses in Section 2. In Section 3, we detail the process of measuring CEO optimism versus over-precision using management earnings forecasts. Section 4 reports our empirical analysis on the link between the two overconfidence measures and managerial decisions. Section 5 concludes the study.

2. Hypotheses Development

Much of the extant empirical literature on CEO overconfidence has focused on how optimism affects corporate investment decisions. For example, Malmendier and Tate (2005) find

supporting evidence that firms with optimistic CEOs invest more, especially when the firm is less financially constrained. Hirshleifer, Low, and Teoh (2012) find that optimistic CEOs invest more in innovation. Both of these results are consistent with Heaton (2002), who argues that optimistic CEOs tend to over-invest because they overestimate future project cash flows and therefore perceive some (marginally) negative NPV projects to be positive.

Conversely, Ben-David, Graham, and Harvey (2007) argue that miscalibrated managers underestimate the potential risk associated with investments and, therefore, apply a lower discount rate. Even assuming that their expectation of cash flow is not impacted by their overt precision, overly precise managers may perceive some negative NPV projects to be positive and end up investing more. In the empirical literature, the impact of managerial over-precision on corporate investment decisions has received relatively less attention. One exception is the survey-based study of Ben-David, Graham, and Harvey (2013), who provide some preliminary empirical results showing that firms with miscalibrated CFOs tend to invest more.

Theoretically, Hackbarth (2009) examines the investment behavior of optimistic and miscalibrated managers using a real option framework. He argues that firms with optimistic CEOs would invest early because a higher perceived growth rate in earnings raises the opportunity cost of waiting to invest. Miscalibrated CEOs would also invest early because they view projects as less uncertain, which reduce the option value of waiting for new information. As a result, both optimistic and miscalibrated CEOs would invest early and engage in more investment.

Accordingly, we hypothesize that firms with optimistic CEOs are more likely to invest more because they overestimate the expected investment return. Moreover, firms with overly

precise CEOs are also hypothesized to invest more because they underestimate the investment risk.

H1: *Overconfident CEOs invest more in comparison to non-overconfident CEOs.*

H1a: *Optimistic CEOs invest more in comparison to non-optimistic CEOs.*

H1b: *Overly precise CEOs invest more in comparison to CEOs who are less precise.*

One particular type of investment, acquisition, has received extensive attention in the behavioral corporate finance literature. Starting with the seminal work of Roll (1986), "hubris" theory suggests that managers are too confident about the benefits of mergers and acquisitions and bid excessively for the target. Malmendier and Tate (2008) also find that firms with optimistic CEOs undertake more acquisitions, and especially diversifying acquisitions, i.e., acquisitions of firms in industries that are different from the industries in which the acquirers are currently operating.

Overconfident managers are more likely to engage in acquisitions for two distinct reasons. *First*, optimistic CEOs are likely to overestimate the potential synergies derived from mergers and acquisitions. Therefore, they would be more willing to engage in mergers and acquisitions. *Second*, overly precise managers may perceive acquisitions to be less risky and apply a lower discount rate to determine the NPV of their acquisitions. As a result, they may perceive more acquisition opportunities to have sufficiently high NPVs to undertake. Therefore, we predict that overconfident CEOs would be more likely to engage in acquisitions. Furthermore, we predict that optimistic and/or overly precise CEOs would be more likely to acquire targets in industries in which the acquiring firms have not operated before because estimating synergies and discount rates is even more subjective and difficult in these situations.

H2a: *Optimistic CEOs are more likely to engage in acquisitions (especially diversifying acquisitions) in comparison to non-optimistic CEOs.*

H2b: *Overly precise CEOs are more likely to engage in acquisitions (especially diversifying acquisitions) in comparison to other CEOs.*

Given that we predict overconfident CEOs would invest more and engage in more M&A transactions, we are also interested in how they would finance their investments. The theoretical model developed by Heaton (2002) predicts that manager optimism can lead to pecking-order preferences (i.e., debt over equity) even in the absence of information asymmetry. In a sense, optimistic managers find external financing sources to be unduly costly because they feel that the market underestimates future firm performance. In this case, they view equity to be more severely mispriced or undervalued than debt, thus inducing these managers to prefer debt to equity when accessing external capital markets. Empirically, Malmendier, Tate, and Yan (2011) provide some evidence that optimistic CEOs issue more debt to cover financing deficits.

Hackbarth (2008) extends Heaton's (2002) model to examine the impact of both optimism and miscalibration. In Hackbarth's (2008) model, managerial optimism and miscalibration about assets-in-place lead to a preference for higher leverage and more debt issuance because overconfident managers believe that their firms are more profitable or less risky -- and thus less prone to financial distress -- than the market's view. In particular, optimistic managers overestimate the growth of future earnings, and therefore view external financing as unduly costly, particularly for equity financing as it is more sensitive to biases in beliefs. On the other hand, Hackbarth (2008) predicts that miscalibrated managers exhibit the opposite behavior, in which they follow a reverse pecking order. Miscalibrated managers

underestimate the firm's risk and hence view equity as overpriced since equity is akin to a call option on the firm's assets.

However, as noted by Ben-David, Graham, and Harvey (2007), the model in Hackbarth (2008) assumes that the underestimation of cash flow volatility does not impact the discount rate, which leads to the opposite conclusion that miscalibrated managers perceive equity to be overvalued by the market. Ben-David, Graham, and Harvey (2007) model equity value using Merton's (1974) model, in which lower expected volatility implies a lower option value. However, lower cash flow volatility also reduces discount rates, which increases the value of the underlying asset and hence the option value indirectly. With reasonable model parameters, miscalibrated managers would perceive equity to be undervalued by the market, while debt is only marginally undervalued. Therefore, motivated by Ben-David, Graham, and Harvey (2007), we predict that overly precise managers would also prefer debt to equity when they seek external financing.

H3a: *Optimistic CEOs are more likely to issue debt relative to non-optimistic CEOs.*

H3b: *Overly precise CEOs are more likely to issue debt in comparison to other CEOs.*

3. Measuring Overconfidence

Managerial overconfidence is very challenging to measure as it is not directly observable, particularly for empiricists. The most widely used measure for managerial overconfidence in the finance literature is one developed by Malmendier and Tate (2005, 2008) that is based on managers' option exercise behaviors. Executives generally receive a large amount of stock and option grants as part of their remuneration package. In addition, their human capital and future employment prospects are highly dependent on firm outcomes. Therefore, executives should

seek to diversify by exercising their deep-in-the-money option holdings early to reduce their exposure to firm-specific risks. Nevertheless, some executives hold on to their option holdings for a long period, even until the year of expiration. Hall and Murphy (2002) show that the timing and threshold to exercise options depends on individual wealth, risk aversion, and diversification. Nevertheless, given reasonable calibrations of these parameters, Malmendier and Tate (2005 & 2008) conclude that such late exercise behavior is inconsistent with optimal decision making by executives. As a result, Malmendier and Tate (2005, 2008) classify executives who exhibit such late exercise behavior as overconfident. They argue that these executives are too optimistic about firm future performance, which induces them to hold on to their options beyond the optimal exercise point. Strictly speaking, the option-based measure is designed to measure optimism, the first facet of overconfidence.

However, in empirical work, studies do not usually clearly distinguish between optimism and over-precision. For example, Hribar and Yang (2016) use the option-based measure to examine the impacts of both optimism and miscalibration on management earnings forecasts. Hirshleifer, Low, and Teoh (2012) also use the option-based measure to empirically test the risk-taking of overconfident CEOs. They find that firms with overconfident CEOs are associated with higher stock return volatility.

Recognizing the gap in the empirical studies of overconfidence, Ben-David, Graham, and Harvey (2013) provide the first empirical study attempting to examine optimism and miscalibration separately. In their surveys, Ben-David, Graham, and Harvey (2013) ask CFOs to predict one-year and ten-year S&P 500 future returns. Using the survey responses, they construct (1) a measure of CFO optimism using CFOs' return forecast errors and (2) a measure of CFO miscalibration using the narrowness of their return forecast intervals. The two measures are

arguably more closely aligned with the definition of two aspects of overconfidence employed in the behavioral corporate finance models: optimism is often modelled as overestimation of the mean, while miscalibration is usually defined as the underestimation of risk.

In practice, researchers are severely limited in their ability to capture such distinction across a wider sample of executives. Management earnings forecasts provide us with a unique setting in which alternative overconfident measures can be derived from a larger number of executives. In particular, the vast majority of earnings forecasts issued by management (i.e., 90%, on average) are in the form of a range forecast rather than a point estimate. These range forecasts allow us to separately measure optimism and over-precision. We classify executives who over-forecast earnings as optimistic. Motivated by Ben-David, Graham, and Harvey (2013), we classify executives who issue earnings forecasts with narrower intervals as overly precise.

3.1 Determinants of Management Earnings Forecasts

Cheng and Lo (2006) argue that the CEO of a firm has the greatest influence over a wide range of corporate decisions, including earnings disclosure decisions. They find that managers increase the number of negative earnings forecasts before share purchases, and this effect is stronger for insider trades initiated by CEOs, which suggests that CEOs have the greatest influence over earnings forecasts. Similarly, using the option-based measure of CEO overconfidence, Hribar and Yang (2016) find that CEO overconfidence affects the propriety of management earnings forecasts, which also suggests that CEOs play an important role in earnings disclosure decisions. Therefore, in this study, we attribute the two facets of managerial overconfidence derived from management earnings forecasts to the firms' CEOs. This approach is consistent with Otto (2014), who uses over-forecasts of earnings to identify optimistic CEOs.

Attributing the overconfidence measures at the CEO level is also consistent with the finding reported by Bertrand and Schoar (2003) that managerial style matters.

Management earnings forecasts provide a similar setting to the measurement of overconfidence in Ben-David, Graham, and Harvey (2013). The main difference is that they ask CEOs to predict an exogenous event (e.g., next year's S&P 500 returns) that is not affected by individual firm managers' decisions. Management forecasts can be affected by different firm characteristics and managerial incentives. For example, it may be more difficult to forecast earnings for firms with more volatile earnings, which may result in a larger forecast range that does not necessarily reflect CEO over-precision. To attenuate the effect of these firm and managerial characteristics, we use a regression approach to partial out a range of confounding effects. We subsequently use the residuals to measure the two facets of CEO overconfidence.

Following the prior literature on management earnings forecasts, we use Equation (1) to control for a range of confounding effects:

$$\boldsymbol{PrecisionMFE_t \ or \ Precision_t} = \boldsymbol{\alpha_0} + \sum_{\boldsymbol{i}} \boldsymbol{\beta_i Firm\ Characteristics_{i,t-1}} + \boldsymbol{Industry} * \boldsymbol{Year\ dummies} + \boldsymbol{PE\ Quintile\ dummies} + \boldsymbol{\varepsilon_t} \quad (1)$$

Depending on which hypothesis is being tested -- either relating to optimism or to over-precision -- the dependent variable takes one of two forms. First, with regard to optimism, MFE_t is management forecast error computed as the difference between the mid-point of the forecast range and the actual earnings for year t scaled by the share price at the end of year t-1.[8] Second, with regard to over-precision, $Precision_t$ is defined as the earnings forecast interval for year t scaled by the share price at the end of year t-1 and multiplied by negative one (i.e., -1 for ease of

[8] Actual earnings are obtained from the IBES Guidance database to ensure consistency with the earnings forecasts.

interpretation). That is, a higher value of *Precision* (i.e. a less negative value), the more precise is the forecast and the more overly precise is the CEO. A larger ε_t in each of the two regressions indicates a higher level of optimism and over-precision.

Five commonly used firm-level control variables are drawn from the prior literature on earnings forecasts (e.g., Gong, Li, and Wang 2011; Hribar and Yang 2016): (1) firm size (*Firmsize*); (2) market-to-book ratio (*MB*); (3) return on assets (*ROA*); (4) change in earnings *(*Δ*Earnings*); and (5) accounting accruals (*Accruals*). We also control for three other groups of firm-level factors that have been found to be important in determining management earnings forecasts, namely: (1) the forecasting environment; (2) managerial incentives; and (3) the forecast horizon. We provide detailed definitions and calculations of these control variables in Appendix A.

First, to control for the forecasting environment that managers face when making their earnings forecasts, we also include earnings volatility (*Earnings Vol*) and a dummy variable for a loss-making firm (*Loss*). As documented by Ajinkya, Bhojraj, and Sengupta (2005), firms with more outside directors and higher institutional ownership are more likely to issue more specific and less optimistic earnings forecasts. As a result, we also control for the proportion of independent directors (*Independent*) and institutional ownership (*Inst. Ownership*). As argued by Rogers and Stocken (2005), firms are more likely to issue less optimistic forecasts if the litigation risk is high and when the market is more concentrated in order to discourage new entrants. Bamber and Cheon (1998) also find that when proprietary information costs are high, managers are less willing to reveal information, which results in lower forecast precision. Therefore, we include the Hirfindahl-Hirschman index (*HHI*) to control for the level of industry

competition and a dummy variable for industries with high litigation risk (*Litigation*). All these control variables are measured as of fiscal year t-1.

Second, to control for managerial incentives in providing biased positive earnings forecasts during M&A and financing activities, we follow Gong, Li, and Wang (2011) and Hribar and Yang (2016) and include firms' M&A (*MA*) and financing activities (*Net Equity Issue*) during year t in our regression models. These variables are important for our study because we are examining the impact of overconfidence on firms' investment behavior and merger and acquisition activities and the associated financing decisions. If firms tend to over-forecast earnings prior to engaging in M&As, we could potentially wrongly attribute a positive relation between earnings forecast errors and M&A activities to CEO overconfidence if we do not control for this biased incentive effect.

Third, to control for the information available when a forecast is made, we include the forecast horizon (*Horizon*), which is the number of days between the management forecast date and the fiscal period end date (Bamber and Cheon 1998; Johnson, Kasznik, and Nelson 2001). In the earnings forecasts regression, we also include the Fama-French 48 industries by year fixed effects using the interactions between the 48 industries and year dummies. These variables are used to control for the effects of time-varying industry characteristics and macroeconomic conditions on management earnings forecasts. In addition to the prior literature on management earnings forecasts, we also include dummy variables for the Price-to-Earnings (PE) ratio quintiles in each year. The PE ratio is defined as the ratio of the share price, which is used as a deflator for MFE and Precision, to the mid-point of the earnings forecasts. These variables are included to avoid the mechanical relation introduced by the scaling factor.[9]

[9] For example, suppose two firms issue identical earnings forecasts of \$0.9 to \$1.1 per share, with actual earnings per share realized being \$0.9. The share prices of firms A and B are \$10 and \$20, respectively. Accordingly, firm A

We obtain the optimism and over-precision residuals from the forecast error and forecast precision regressions, respectively. The higher the optimism (over-precision) residuals are, the more optimistic (overly precise) are the CEOs. To reduce the noise contained in these residuals, we aggregate them at the CEO's personal level. That is, we average the residuals from all the earnings forecasts issued by a particular CEO. We then compare the average residual value to the median of the average residual value for all CEOs and form dummy variables based on classifying a CEO as optimistic (overly precise) if the average residual from the forecast error (precision) regression is greater than the median value.

Our decision to employ dummy variables reflects a challenging research design tradeoff. Using dummy variables may result in the loss of some information content in each individual earnings forecast.[10] However, the measurement of overconfidence is inherently difficult as the proxies are plagued by substantial noise, to the extent that the noise component can easily swamp the underlying economic signal. Accordingly, we choose to adopt a cautious and conservative dummy variable method to measure CEO overconfidence.[11]

Our measures of optimism and over-precision should be viewed as *relative* measures among CEOs, as we are not comparing them to theoretically unbiased forecasts. However, this approach is sufficient for our task because we are interested in how the relative variation in the level of optimism and over-precision is related to the relative outcome of firm policies.

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has a PE ratio of 10 based on the forecast mid-point of $1 per share, while firm B has a PE ratio of 20. All else being equal, in this case, firm A will have a higher forecast error and a lower (i.e., more negative) forecast precision than its counterpart firm B. However, this misleading conclusion is driven by the lower PE ratio of firm A. As a result, if we do not control for the difference in PE ratios, our overconfidence measure derived from the regression will be mechanically correlated with the PE ratio when we use share price as the scaling factor and will bias the results of our subsequent tests. Notably, our results are qualitatively similar if we exclude the PE ratio quintile dummies and only include the Fama-French 48 industries by year fixed effects.

[10] The dummy variable classification approach assumes that CEO overconfidence is a personal fixed effect; hence, it is not time-varying. We address the issue of overconfidence persistence in Section 3.5.

[11] The percentage of CEOs classified as optimistic or overly precise may be slightly different from 50% in the main tests, as the sample of CEOs used may differ due to the availability of data for each regression.

3.2 Descriptive Statistics

3.2.1 Sample Selection and Data Sources

We retrieve all management earnings forecasts data in the period from 2001 to 2014 from the IBES Guidance database. This database provide relatively comprehensive coverage starting from 1995. However, we restrict our sample to start from 2001, because only limited number of management earnings forecasts are available before the passage of the Regulation Fair Disclosure on October 23, 2000. This sample restriction is also observed in Hribar and Yang (2016).

Qualitative and open-ended forecasts are excluded because they are not specific enough to define forecast errors and ranges. As argued by Hribar and Yang (2016), management overconfidence is more likely to manifest itself in annual earnings forecasts where the earnings are most likely to be uncertain. Accordingly, we only retain annual earnings forecasts to identify overconfident managers. Following the prior literature (e.g., Cheng, Luo, and Yue 2013; Gong, Li, and Wang 2011), we exclude pre-announcement forecasts (i.e., forecasts made after fiscal period end) and forecasts made in previous fiscal years, as the information available to managers for such forecasts could be materially different from other forecasts made during the year. To maximize the observations of management earnings forecasts and hence reduce the noise in the overconfidence measure, we retain all forecasts made during the fiscal year.

To identify the CEO in each year, we merge our earnings forecast data with data from Execucomp. The main limitation of our analysis is that Execucomp only covers S&P 1500 firms. However, this restriction is also necessary as various CEO-level control variables in our main

tests, such as stock and option ownership, are derived from Execucomp.[12] We then match our sample of earnings forecasts to the CRSP/Compustat Merged (CCM) database to obtain firm-level control variables. Board information and institutional ownership are derived from RiskMetrics and Thomson Reuters, respectively. Lastly, to be consistent with our main tests, we exclude financial firms (SIC codes between 6000 and 6999).

3.2.2 Descriptive Statistics for Management Earnings Forecasts

Table 1 reports the sample selection procedure and the distribution of the management earnings forecasts. Panel A shows that there are 20,300 management earnings forecasts with non-missing control variables. Panel B presents the time-series distribution and the percentage of range forecasts for each year. Generally, the number of earnings forecasts within our sample has increased over time. In recent years, the number of earnings forecasts captured by our sampling has been quite stable at approximately 1,600 to 1,800 per year. Among the 20,300 forecasts, 18,375 (89.77%) of them are in the form of a range, and the remaining 1,925 (10.23%) are point estimates. Our very high percentage of range estimates is consistent with the findings documented by Hribar and Yang (2016).

[Table 1 about here]

In unreported results, approximately 43.4% of the firm-year observations and 51.5% of the CEOs in our sample have at least one earnings forecast. As a result, the management earnings forecast-based overconfidence measure is available for a large portion of the CEOs in our sample. Of those CEOs that issue earnings forecasts, on average, fifteen sampled earnings forecast estimates are available throughout the sample period.

[12] This restriction also applies to other studies such as Hirshleifer et al. (2012), who rely on Execucomp stock options data to measure CEO overconfidence.

Table 2 reports the summary statistics of variables in the management earnings forecast regressions. All variables are winsorized at 1% and 99% to eliminate the effect of outliers. On average, CEOs slightly under-forecast relative to the actual earnings in our sample, as evidenced by the negative *MFE*. The average range forecasts provided by CEOs are approximately 0.4% of the share price, and the average gap between earnings forecasts and the fiscal year end is approximately 196 days. The firm-level control variables are generally in line with Gong, Li, and Xie (2009) and Hribar and Yang (2016). More specifically, on average, 6.3% of the firm-year observations in our sample represent loss-making firms, while 21.7% engage in M&A activity and 3.1% issue equity that is greater than 5% of total firm assets (i.e., *Net Equity Issue*). In our sample, a typical firm has a market-to-book value of 3.3, and its rate of return on assets is 6.8%. Moreover, the majority of directors are independent directors (75.5%). The sample average institutional investors ownership is approximately 76.3%.

[Table 2 about here]

3.3 Estimation Results for CEO Overconfidence Measures

Table 3 presents the results for the management earnings forecast error and precision regressions in columns (1) and (2), respectively. Column (1) indicates that larger firms over-forecast their earnings, while growth firms under-forecast their earnings. Consistent with Gong, Li, and Xie (2009), we find that firms with higher accruals are associated with higher forecast errors. We also observe that firms are more likely to issue optimistic forecasts when the forecast is made more distant in time from the fiscal year end. However, we do not find that independent directors and institutional ownership reduce forecast optimism, in contrast to the findings in Ajinkya, Bhojraj, and Sengupta (2005). Moreover, industry concentration and litigation do not

seem to have the effect of reducing forecast errors in our sample, consistent with the findings reported by Gong, Li, and Wang (2011).

[Table 3 about here]

Turning to the forecast precision regression in column (2), firms with larger size, higher growth and higher profitability provide more precise earnings forecasts. Similar to Cheng, Luo, and Yue (2013), our results suggest that firms reduce their forecast precision when facing higher earnings uncertainty. This result is shown by the negative relation between earnings forecast precision and earnings volatility, the loss-making indicator, and the forecast horizon. Consistent with Ajinkya, Bhojraj, and Sengupta (2005), firms with higher institutional ownership are associated with narrower forecast intervals. In our sample, firms issue more precise earnings forecasts when the litigation risk is high and when they are about to engage in M&A transactions. On the other hand, firms with higher accruals and larger proportion of independent directors are more likely to issue less precise forecasts.

As described in Section 3.1, we classify CEOs as optimistic and overly precise using residuals from the respective regressions in Table 3. We present the residuals from the earnings forecast error and precision regressions in Panels A and B in Figure 1, respectively. Both series of residuals are centered at approximately 0 and are close to a normal distribution. As discussed earlier, we average the residuals of the earnings forecast errors (precision) by each CEO and classify each CEO as optimistic (overly precise) if their average residuals from the earnings forecast error (precision) regression are greater than the median of all their counterpart CEOs' average residuals. Our measures of optimism and over-precision have a negative correlation of

12.2% with a p-value of less than 1%, which is consistent with Moore and Healy (2008)'s finding that over-precision seems to reduce the effect of optimism.

[Figure 1 about here]

3.4 Are CEOs Overly Precise?

We have so far attributed narrower earnings forecast ranges to CEO over-precision. However, such behavior might not necessarily reflect over-precision, but rather superior forecasting skill. With this alternative explanation, we would expect the probability of actual earnings falling within overly precise CEOs' narrower earnings forecast ranges to be at least as high as that for other CEOs, reflecting their superior earnings forecasting skills. Therefore, we examine whether our over-precision measure is merely a reflection of better forecasting skills.

Earnings forecasts provide price-sensitive information to the market, and they are an important channel for management to distribute information (Gong, Li, and Xie 2009). As a result, managers are expected to provide a forecast range in which they have high confidence. Although we do not have a specific threshold for such a confidence interval and it probably varies across time and managers, a relatively high value is expected. For example, if managers allow one standard deviation in their forecasts and the distribution of earnings is normal, we would expect 67% of the actual earnings to fall within the forecast range.

Table 4 reports the distribution of actual earnings when compared to the earnings forecast ranges. Specifically, we are interested in the proportion of actual earnings that fall outside of the forecast range. As shown in Table 4, out of 18,375 range forecasts issued in our sample, approximately 67.0% of the actual earnings fall outside of the forecast range. This point estimate is conservative, as we have excluded point forecasts, i.e., those forecasts with range of zero.

This result is quite surprising, and it indicates that managers are generally too confident in their ability to forecast earnings accurately. This result is consistent with Goel and Thakor (2008), who model firms' internal promotion processes as a tournament where overconfident CEOs have a better chance of being promoted to CEO. Given this observation, it is important to re-emphasize that our measure of over-precision is a relative measure, as most CEOs could be classified as overly precise by most reasonable benchmarks.

[Table 4 about here]

Table 4 further reports the distribution of actual earnings compared to the earnings forecasts issued by two groups of CEOs based on their over-precision. For CEOs with higher precision measures, 71.3% of actual earnings are outside of their forecast ranges, in comparison to only 62.8% for other CEOs. This indicates that our over-precision measure indeed captures behavioral bias rather than better forecasting skills.

To formally test whether our over-precision measure captures superior forecasting skill, we estimate a logistic regression to model the likelihood of actual earnings falling outside of the forecast range. We define the dependent variable, *OUT*, as a dummy variable that takes the value of one if the actual earnings falls outside of the forecast range and zero otherwise. We have included the same set of control variables as in the earnings forecast precision regression. The main variable of interest is our measure of over-precision. If this measure captures forecasting skill, we would expect a negative (or non-significant) sign. In contrast, a positive sign would indicate that the measure captures over-precision bias.

[Table 5 about here]

Table 5 presents the results of the logistic regression. Confirming our univariate findings in Table 4, CEOs classified as overly precise are more likely to issue earnings forecast ranges that are too narrow, i.e., where the actual earnings subsequently fall outside of the forecast ranges. Optimism, on the other hand, is *negatively* correlated (albeit not statistically significant) with the probability of earnings falling outside of the forecast range. When we change our dependent variable to *OUT Low*, which takes a value of one if the actual earnings fall below the lower bound of the earnings forecasts, the results show that CEOs that we identify as optimistic have a much higher probability (17.9% higher in unreported results) of having the actual earnings fall lower than the forecast range, consistent with these CEOs being overly optimistic in their earnings forecasts.

3.5 Persistence of Overconfidence

We treat CEO optimism and over-precision as a personal fixed effect, which is consistent with studies that use the option-based measure of overconfidence (e.g., Malmendier and Tate 2005, 2008). In this section, we check whether the assumption of overconfidence persistence is statistically valid.

Instead of aggregating the residuals at the CEO level across all years, we classify CEOs as optimistic or overly precise year by year as long as they have a valid earnings forecast during a given year. Specifically, we average the residuals from the earnings forecast regressions for a CEO each year and classify the CEO as optimistic or overly precise if the average value is greater than the median value for all CEOs for that year. If CEO overconfidence is persistent over time, we would observe that past-year optimism or over-precision has predictive power for an optimism or over-precision classification in the current year, respectively.

Table 6 reports the logistic regressions modeling the likelihood of being classified as optimistic (overly precise) using past one-year and/or two-year optimism (over-precision) as independent variables. The results show that a past-year classification is significantly positively correlated with the likelihood of being classified as optimistic or overly precise again in the current year. Consistent with Moore and Healy (2008), we find that over-precision is quite persistent, and more so than over-optimism. Specifically, the probability of a CEO classified as overly precise (optimistic) increases from 25.8% (39.2%) to 74.2% (61.3%) if he/she was classified as overly precise (optimistic) last year. Therefore, our assumption of overconfidence persistence appears to be reasonable.

[Table 6 about here]

4 CEO Overconfidence and Corporate Investment and Financing Decisions

Our Hypothesis 1 and Hypothesis 2 predict that both optimistic and overly precise CEOs invest more and engage in more M&As in comparison to other CEOs, while Hypothesis 3 predicts that overconfident CEOs issue more debt.

4.1 Research Design

4.1.1 Sample Selection and Data Sources

We obtain firm-level variables from Compustat for the sample period from 2001 to 2014. We restrict our sample to start in 2001 due to the increased availability of management earnings forecast data to measure CEO overconfidence after the passage of the Regulation Fair Disclosure on October 23, 2000. Stock returns are collected from CRSP. Executives' personal-level data such as option and stock ownership are obtained from Execucomp. Following convention, we

exclude financial firms (SIC codes between 6000 and 6999) in our main tests. To eliminate the effect of outliers, we winsorize all variables at 1% and 99%. In total, we have 6,286 observations with non-missing CEO optimism, CEO over-precision and firm-level control variables, and we label this sample the "investment sample".

4.1.2 Model Specification

$$
\begin{aligned}
&Investment\ Measure_t \\
&\quad = \alpha_0 + \alpha_1 OverOptimism + \alpha_2 OverPrecision \\
&\quad + \sum_i \beta_i Firm\ Characteristics_{i,t-1} + \gamma_1 CEO\ Delta_{\ i,t-1} \\
&\quad + \gamma_2 CEO\ Vega_{\ i,t-1} + Industry\ dummies + year\ dummies + \varepsilon_t
\end{aligned}
\tag{2}
$$

We use Equation (2) to test our Hypotheses 1 and 2 on corporate investment and M&A activities. Our main variables of interest are CEO *Optimism* and *Over-Precision*, which are defined using management earnings forecast data, as described in Section 3. As predicted by Hypotheses 1 and 2, optimistic and overly precise CEOs would both invest more and engage in more M&As.

H1a & H2a: $\alpha_1 > 0$

H1b & H2b: $\alpha_2 > 0$.

The investment analysis employs the following five alternative measures of investment: (1) *Total Real Investment*; (2) *Total Capex*; (3) *Acquisition*; (4) *Expansion Capex;* and (5) *R&D*. *Total Real Investment* is defined as capital expenditures (*capx*, Compustat acronym) plus acquisitions (*aqc*) less sales of property, plant and equipment (*sppe*). This definition is slightly

different from that used by Ben-David, Graham, and Harvey (2013), who also include increases and sales of investments (*inch, siv*) in the calculation of total investment.[13] However, their measure could potentially include financial investments such as investments in securities, whereas we are more interested in investments in real assets. We then separate *Total Real Investment* into *Total Capex* and *Acquisition.* Our definition of *Total Capex* is consistent with Coles, Daniel, and Naveen (2006), who define it as capital expenditures less sales of property, plant and equipment. We then further divide *Total Capex* into *Expansion Capex* and Sustaining Capex (proxied by depreciation and amortization, *dp*). Moreover, we are also interested in the impact of overconfidence on R&D spending, and we use *R&D* (*rdx*) as one of the investment dependent variables.[14] The relations between our various measures of investment are summarized in Figure 2.

[Figure 2 about here]

All control variables are consistent with the prior literature (Ben-David, Graham, and Harvey 2013; Coles, Daniel, and Naveen 2006; Hirshleifer, Low, and Teoh 2012). Specifically, our set of control variables comprise: *Sales*, capital intensity measured as property, plant and equipment per employee (*PPE/Emp*), *Stock Return, Tobin's Q, Sales Growth, Profitability, Book Leverage, Cash, Vega and Delta*.[15] All control variables are defined in Appendix A.

[13] Our results are qualitatively similar when using the total investment measure in Ben-David, Graham, and Harvey (2013).

[14] We have replaced missing R&D values with zero. However, our results are not sensitive to including a dummy variable to denote missing R&D values, as suggested by Koh and Reeb (2015).

[15] Coles, Daniel, and Naveen (2006) find that CEOs with higher sensitivity of wealth to stock volatility (Vega) invest more in R&D but less in property, plant and equipment (PPE). On the other hand, CEOs with higher sensitivity of wealth to share price (Delta) invest less in R&D but more in PPE. As a result, we have also included Delta and Vega of the CEO as additional control variables. The calculation of Delta and Vega follows Core and Guay (2002).

4.2 Descriptive Statistics for the Investment Sample

Table 7 reports the summary statistics of our investment sample for both the dependent and independent variables. Approximately half of our firm-year observations is classified as optimistic or overly precise CEOs, respectively. This percentage may vary slightly because we have to drop some observations with missing information for the investment measures.

[Table 7 about here]

Firms in our investment sample invest approximately 9.4% of their total assets in real assets in a year, and this amount is broken down into total capital expenditures (4.6%) and acquisitions (4.3%). Of the 4.6% of total capital expenditures, only 0.2% is used for the expansion of capital expenditures, while the rest (4.4%) is used for sustaining capital expenditures. Similarly, when comparing expansion capex to acquisitions of 4.3%, our sample firms tend to invest in external acquisitions rather than internal growth. All the other control variables are comparable to Coles, Daniel, and Naveen (2006) and Hirshleifer, Low, and Teoh (2012).

Panel B of Table 7 further separates our investment sample into firm-year observations with optimistic and non-optimistic CEOs. We classify approximately 610 CEOs as optimistic, out of 1,222 CEOs in our sample. Generally, there are no significant differences between optimistic and non-optimistic CEOs in terms of the five investment measures used in this study. Surprisingly, firms with non-optimistic CEOs appear to invest more in the R&D expenditures in a univariate setting. For the control variables, firms with optimistic CEOs tend to be smaller, have lower stock returns, have lower growth opportunities (indicated by a lower *Tobin's Q)*, have lower sales growth, and hold lower cash positions, but they have higher leverage. CEOs

who are classified as optimistic also have lower *Delta* and *Vega* values than non-optimistic CEOs.

Panel C of Table 7 divides the investment sample based on a different dimension, namely over-precision. Approximately 615 CEOs out of 1,222 CEOs are classified as overly precise. In contrast to the sample split based on the measure of optimism, firms with overly precise CEOs invest more in real assets -- driven by both higher amount of acquisitions and higher level of total capital expenditures. They also have higher level of R&D expenditures. Firms with overly precise CEOs are smaller, have lower capital intensity and lower leverage, but they have higher stock returns, higher growth opportunities and higher sales growth rates. Overly precise CEOs are found to have higher *Delta* and *Vega* values than other CEOs.

4.3 Corporate Investment Decisions

To formally test our predictions in Hypotheses 1 and 2 that stipulate that optimistic and overly precise CEOs invest more and engage in more M&As, we empirically estimate Equation (2). The regression results are reported in Table 8.

[Table 8 about here]

Column (1) in Table 8 estimates the relation between the two facets of CEO overconfidence and total real investment. The results show that firms with overly precise CEOs generally invest more in real assets. Given that the sample average of total real asset investment is approximately 9.4% of total assets, being overly precise increases it to 10.4%, which, in the context of our sample, reflects an approximately 10.7% (or $75 million) increase in average real asset investment. However, we do not find that CEO optimism has a significant impact on total

real asset investment decisions. Our overall results are consistent with Ben-David, Graham, and Harvey (2007), who find that overly precise CFOs invest more, while optimistic CFOs do not.

We partition total real asset investment into total capital expenditures in column (2) and acquisitions in column (3). We find that the increase in total real asset investment is mainly driven by the higher number of acquisitions associated with overly precise CEOs. The economic magnitude is also large. Overly precise CEOs spend 22% more on acquisitions than other CEOs, which suggests that overly precise CEOs have a strong preference for external acquisitions. We also further partition total capital expenditures into sustaining and expanding capital expenditures in column (4). We find that overly precise CEOs are not associated with expanding capital expenditures. Again, CEO optimism is not observed to have any impact on investment decisions.

To capture CEOs' preference between external acquisitions and internal growth through the expansion of capital expenditures, we use a dependent variable that measures the difference between acquisition spending (*aqc*) and internal expansion of capital expenditures (*capx-sppe-dp*). Column (5) shows that overly precise CEOs prefer external growth more than other CEOs. Specifically, overly precise CEOs are associated with an increase of 1.1% of total assets, which represents an approximately 25% increase in the difference between acquisition and expansion capex relative to the mean difference in the full sample of approximately 4.5% of total assets.

Finally, we are also interested in how CEO overconfidence is related to R&D expenditures. Using the option-based measure of overconfidence, Hirshleifer, Low, and Teoh (2012) provide evidence that optimistic CEOs spend more on R&D expenditures because they overestimate the probability of success. However, we do not find evidence that either optimism or over-precision has significant influence over R&D expenditure in our sample.

With regard to the control variables, larger firms generally invest less in terms of the proportion of total assets. Firms with higher capital intensity and growth opportunities prefer to grow internally rather than by making acquisitions. We also observe that strong stock performance generally increases investment but decreases R&D expenditures. Firms with higher sales growths invest more in acquisitions, expansion capex and R&D expenditures. Not surprisingly, more profitable firms invest more in both total capex and acquisition expenditures. However, profitable firms invest less in R&D. On the other hand, higher leveraged firms reduce real investments and R&D expenditures. Consistent with Harford (1999), firms with high cash positions tend to invest more in acquisitions. Our estimates are also consistent with Coles, Daniel, and Naveen (2006), who show that CEOs with higher *Vega (Delta)* values invest more (less) in R&D expenditures but reduce (increase) capital expenditures.

In sum, our results suggest that overly precise CEOs have a strong preference for external acquisitions. On the other hand, optimistic CEOs do not seem to differ in capital expenditure decisions.

4.4 Mergers & Acquisitions

Our results in Section 4.3 suggest that overly precise CEOs invest more than other CEOs in M&A activities. In this section, we aim to provide further evidence using an alternative source of data, the Thomson SDC database. Malmendier and Tate (2008) document a positive relation between CEO optimism and M&A activities, in particular, diversifying M&As. We collect all M&A transaction data from the Thomson SDC database from 2001 to 2014. Deals where the acquirer already holds more than 51% of the target are deleted. In addition, we only retain deals where an acquirer owns more than 51% of the target after the deal and, hence, have the

controlling stake. Following Malmendier and Tate (2008), we exclude deals in which the acquisitions are worth less than 5% of the acquirer's equity value.[16]

We then match the M&A transaction data to our main investment sample. We create a dummy variable, *MA*, that takes a value of 1 if a firm engages in at least one M&A transaction during the year and zero otherwise. We also create another dummy variable, *MA_DIV*, which takes a value of one if the firm completes at least one diversifying M&A transaction during the year and zero otherwise. An M&A transaction is defined as diversifying if the acquirer and the target are not in the same Fama-French 48 industry.

$$\Pr\left(\frac{MA}{MA_{DIV}}_{it} = 1\right) = \alpha_0 + \alpha_1 OverOptimism + \alpha_2 OverPrecision + \sum_i \beta_i Firm\ Characteristics_{i,t-1} + \gamma_1 CEO\ Delta_{\ i,t-1} + \gamma_2 CEO\ Vega_{\ i,t-1} + Industry\ dummies + year\ dummies + \varepsilon_t \quad (3)$$

We use Equation (3) to model the likelihood of firms engaging in M&A (and diversifying M&A) transactions using a logistic regression. Consistent with H2, we predict that both α_1 and α_2 to be positive. The dependent variables are *MA* and *MA_DIV*, as described above. All control variables are identical to the control variables used in the investment regressions in Section 4.2, and they are defined in Appendix A. Fama-French 48 industries and year dummies are also included.

[16] Malmendier and Tate (2008) consider this criterion to be important because acquisitions of small units of another company might not have much CEO involvement. Notably, our results are not sensitive to this 5% restriction. Furthermore, our results are robust to another alternative criterion, which is to retain all transactions with values of over $1 million (Moeller, Schlingemann, and Stulz 2004).

Table 9 reports the estimates from the logistic regressions of M&A decisions. Consistent with our findings in Section 4.3, firms with overly precise CEOs are more likely to acquire. In particular, they tend to target firms in industries different from the firms' own industry. In contrast, CEO optimism does not have any significant link with M&A activities. As such, our results are quite distinct from Malmendier and Tate (2008), who find that CEO optimism is an important determinant of M&A activities. Our results indicate that CEO over-precision is the more dominant aspect of overconfidence with regards to corporate acquisitions.

[Table 9 about here]

With regard to the control variables, we find that larger firms are less likely to acquire in our sample. Firms with a lower Tobin's Q are more acquisitive, which suggests that those firms substitute external acquisitions for internal growth (Malmendier and Tate 2008). Firms with higher past stock returns and higher profitability are more likely to acquire. Consistent with Harford (1999), firms are more likely to acquire when positive cash is high, supporting the managerial empire-building hypothesis. Consistent with Coles, Daniel, and Naveen (2006), CEOs with higher *Vega* are more acquisitive.

4.5 Corporate Financing Activities

Our results so far indicate that overly precise CEOs invest more, especially in M&A transactions. In this section, we examine whether and how optimistic and overly precise CEOs finance their investments differently. Specifically, as predicted by Hypothesis 3, we expect both optimistic and overly precise CEOs to issue more debt than equity because both types perceive external risky securities to be undervalued by the market, and they believe that equity is more sensitive to the disagreement between themselves and investors.

We collect the following three types of security issuance data for the period between 2001 and 2014 from the Thomson SDC database: (1) equity issuance; (2) debt issuance; and (3) convertible issuance. We then match this data with our earlier investment sample and create three financing dummy variables. First, if a firm issues common stock or non-convertible preferred stock during the year, we assign a value of one to a dummy variable, namely *Equity Issue*, in that year and zero otherwise. Second, we create *Hybrid Issue,* takes a value of one if a firm during that year issues either convertible debt or convertible preferred shares. Third, we construct a dummy variable, *Debt Issue*, to indicate whether a firm issues debt during the year.

To examine our financing hypotheses, we use a logistic regression to model the likelihood that a specific type of external security will be issued by a firm, and the equation is given below.

$$\begin{aligned}\Pr(Issue_{it} = 1) &= \alpha_0 + \alpha_1 OverOptimism + \alpha_2 OverPrecision \\ &+ \sum_i \beta_i Firm\ Characteristics_{i,t-1} + \gamma_1 CEO\ Delta_{\ i,t-1} \\ &+ \gamma_2 CEO\ Vega_{\ i,t-1} + Industry\ dummies + year\ dummies + \varepsilon_t\end{aligned} \quad (4)$$

The dependent variable, $Issue_{it}$, can assume one of the dummy variables defined above: (1) *Equity Issue*; (2) *Hybrid Issue*; or (3) *Debt Issue*. When our dependent variable is *Debt_Issue*, the prediction is for H3a: $\alpha_1 > 0$ & H3b: $\alpha_2 > 0$. Consistent with Malmendier, Tate, and Yan (2011), we include the following eight control variables: (1) *Sales*; (2) asset tangibility (*Tangibility*); (3) *Stock Return*; (4) *Tobin's Q*; (5) *Profitability; (6) Book Leverage; (7) Delta;*

and (8) *Vega*. All control variables are defined in Appendix A. We also include Fama-French 48 industry fixed effects and year fixed effects in all regressions.

For a robustness check, we use a balance sheet approach with Compustat data. Following Hovakimian, Opler, and Titman (2001), we construct the following two dummy variables: (1) Net Debt Issuer and (2) Net Equity Issuer. First, we classify a firm as a net debt issuer and assign a value of one to *Net Debt Issue* in year *t* if the change in total debt outstanding between year *t* and year *t*-1 is greater than 5% of the total assets and zero otherwise. Second, we classify a firm as a net equity issuer and assign a value of one to *Net Equity Issue* in year *t* if the difference between common stock issuance and common stock repurchases in year *t* is greater than 5% of the total assets and zero otherwise.

Table 10 presents the results for the empirical estimation of Equation (4). Consistent with our expectations, Column (3) shows that firms with overly precise CEOs are more likely to issue debt.[17] At the same time, firms with overly precise CEOs do not seem to issue more equity or hybrid securities. The results of our balance sheet approach in columns (4) and (5) also show that overly precise CEOs tend to increase their debt level, supporting the evidence from the issuance approach. The coefficients for *Optimism* are not statistically significant. As will be discussed shortly in Section 4.6, *Optimism* is positively correlated with *Net Debt Issue* at a p-value of 5.5% once the sample selection issue is controlled. Interestingly, optimistic CEOs also tend to issue more convertibles. Nevertheless, neither optimistic nor overly precise CEOs are inclined to issue more equity. Overall, the results support our prediction in Hypothesis 3.

[Table 10]

[17] Malmendier et al. (2011) restrict their sample to firms with at least one security issuance during the year. We find similar results when this restriction is imposed. That is, conditional on firms accessing an external capital market, firms with optimistic or overly precise CEOs are more likely to issue debt.

4.6 Robustness Checks for Optimism and Over-Precision Measures

A potential concern with our earnings forecast-based measure of overconfidence is a sample selection issue. To be able to calculate CEO optimism or over-precision in Section 3.1, we first need the firms to provide earnings forecasts, and do so as a range. As a result, a firm-year combination can only enter into our final sample if there is at least one earnings forecast made by the CEO during the sample period. If the determinants of issuing management earnings forecasts are correlated with the determinants of corporate investment and financing decisions, then a sample selection bias concern can arise. In this section, we employ Heckman's two-step sample selection model to address this issue.

In the first step, we follow Otto (2014) and model the selection indicator on the CEO level as a function of the average values of the following variables: (1) number of analysts following (obtained from the IBES database); (2) earnings volatility; (3) institutional ownership; (4) net debt issuance; and (5) net equity issuance during the sample period. We use the average value of these five determinants because our two CEO overconfidence measures rely on the average earnings forecast errors or precision from all forecasts made by a particular CEO. In this first step, we also further include the control variables used in our corporate investment and financing regressions in Tables 8 and 10, Fama-French 48 industry fixed effects and year fixed effects.

In the second step, we rerun all our corporate investment and financing regressions after including an Inverse Mills ratio (IMR). The untabulated results are qualitatively similar to the results reported in the earlier sections. The only exception is the *Net Debt Issue* regression corresponding to Column 4 of Table 10. *Optimism* is positively correlated with *Net Debt Issue* at

a p-value of 5.5% once the sample selection issue is controlled. More importantly, the estimate for *Over-Precision* in the debt regression continues to be positive and statistically significant.

5 Conclusion

In this study, we construct new measures of distinct aspects of CEO overconfidence using management earnings forecasts. These forecasts are typically issued in the form of a range, providing us with an opportunity to separately measure optimism and over-precision. We measure optimism using the earnings forecast error, while over-precision is measured using the narrowness of the forecast range. Compared to existing measures of overconfidence, such as the option-based measure used in Malmendier and Tate (2005, 2008), our measure is more directly tied to the overconfidence constructs used in theoretical models (e.g., Hackbarth, 2008).

Our measures indicate that CEOs are generally overly precise. Approximately 67.0% of actual earnings fall *outside* of the management earnings forecast ranges. More importantly, our measure of over-precision is associated with a higher probability of actual earnings falling outside of the range, suggesting that our measure captures behavioral bias rather than superior forecasting skills.

We then provide evidence regarding how CEO optimism and over-precision are related to corporate investment and financing decisions. CEOs with overt precision are associated with a higher level of investment, which is mainly driven by higher acquisition spending. Overly precise CEOs are more likely to acquire other firms, particularly those in different industries, i.e., diversifying acquisitions. Conversely, optimistic CEOs do not seem to invest more in real assets. Neither optimistic nor overly precise CEOs spend more on R&D expenditures. Examining the impact of overconfidence on corporate financing activities, we find that both optimistic and

overly precise CEOs are more likely to issue debt than equity securities after controlling for a sample selection issue. Optimistic CEOs are also more prone to issue convertible securities.

Most importantly, this study shows that managerial over-precision and optimism are related to corporate financial policies in different ways. Therefore, it is important for future empirical studies to distinguish between these two manifestations of overconfidence, potentially using the newly developed measures of over-precision and optimism in this study.

Appendix A Variable Measurement

Panel A: Management Earnings Forecast Regression Variables

Variable	Measurement
Dependent Variable	
MFE	Management forecast error, computed as the difference between the mid-point of the forecast and the actual earnings for year t, scaled by the share price at the end of year t-1.
Precision	Management forecast precision, defined as the earnings forecast intervals for year t, scaled by the share price at the end of year t-1 and multiplied by negative one (i.e., -1).
Independent Variables	
Firmsize	The natural log of the firm's total assets in year t.
MB	Market-to-book ratio, calculated as the ratio of the market value of equity to the book value of equity in year t.
ROA	Return on assets, calculated as income before extraordinary items divided by total assets in year t-1.
Δ*Earnings*	Change in earnings, calculated as the change in earnings before extraordinary items from year t-1 to year t, scaled by the year-end market value of equity.
Accrual	The difference between income before extraordinary items and operating cash flows in year t, scaled by lagged total assets.
Earnings Vol	Earnings volatility, calculated as the standard deviation of income before extraordinary items scaled by average total assets over the past 5 years including year t.
Loss	An indicator that equals one if the firm reports an earnings loss in year t.
Independent	The percentage of independent directors on the board in year t.
Inst Ownership	The percentage of institutional ownership in year t.
HHI	The industry concentration index, measured as the Herfindahl-Hirschman index on sales revenue calculated based on the 4-digit SIC code.
Litigation Risk	An indicator that equals one for litigious industries, including Biotech (SIC 2833 to 2836), Computer Hardware (SIC 3570 to 3577), Electronics (SIC 3600 to 3674), Retailing (SIC 5200 to 5961), and Computer Software (SIC 7371 to 7379), and zero otherwise.
MA	An indicator that equals one if the firm's acquisition costs exceed 5% of its total assets for year t and zero otherwise.
Net Equity Issue	An indicator that equals one if the firm's net share issuance exceeds 5% of its total assets for year t and zero otherwise.
Horizon	The number of days between the management forecast day and the fiscal year end day.

Panel B: Investment and Financing Regression Variables

Variable	Measurement
Dependent Variable	
Total Real Investment	Measured as capital expenditures plus acquisition costs minus the sales of property, plant and equipment in year t.
Total Capex	Measured as capital expenditures minus the sales of property, plant and equipment in year t.
Acquisition	Acquisition costs in year t.
Exp. Capex	Measured as capital expenditures minus the sales of property, plant and equipment minus depreciation and amortization in year t.
R&D	Research and development expenditures in year t. Missing values are replaced with 0.
MA	An indicator that equals one if the firm has at least one acquisition during year t and zero otherwise.
MA_DIV	An indicator that equals one if the firm has at least one diversifying acquisition (target in a different Fama-French 48 industry) during year t and zero otherwise.
Equity Issue	An indicator that equals one if the firm has issued common equity or preferred shares during year t and zero otherwise.
Hybrid Issue	An indicator that equals one if the firm has issued convertible preferred shares or convertible bonds during year t and zero otherwise.
Debt Issue	An indicator that equals one if the firm has issued non-convertible bonds during year t and zero otherwise.
Net Debt Issue	An indicator that equals one if the firm's net debt issuance exceeds 5% of its total assets during year t and zero otherwise.
Net Equity Issue	An indicator that equals one if the firm's net equity issuance exceeds 5% of its total assets during year t and zero otherwise.
Independent Variables	
Optimism	An indicator that equals one if the CEO is classified as optimistic according to the process described in Section 3 and zero otherwise.
Over-Precision	An indicator that equals one if the CEO is classified as over-precise according to the process described in Section 3 and zero otherwise.
Sales	Sales revenue in $mil in year t.
PPE/Emp	Ratio of net property, plant and equipment to the number of employees in year t.
Tangibility	Net property, plant and equipment scaled by total assets in year t.
Stock Return	The buy-and-hold stock return during fiscal year t.
Tobin's Q	Ratio of market value to book value of assets in year t.
Sales Growth	Log transformation of sales in year t divided by sales in year t-1.
Profitability	Ratio of operating income before depreciation in year t to total assets in year t-1.
Book Leverage	Ratio of the sum of long-term debt and short-term debt to total assets in year t.
Cash	Ratio of cash holdings to total assets in year t.

Delta	Dollar change ($000) in CEO stock and option holdings corresponding to a 1% change in the stock price in year t.
Vega	Dollar change ($000) in CEO option holdings corresponding to a 1% change in stock volatility in year t.

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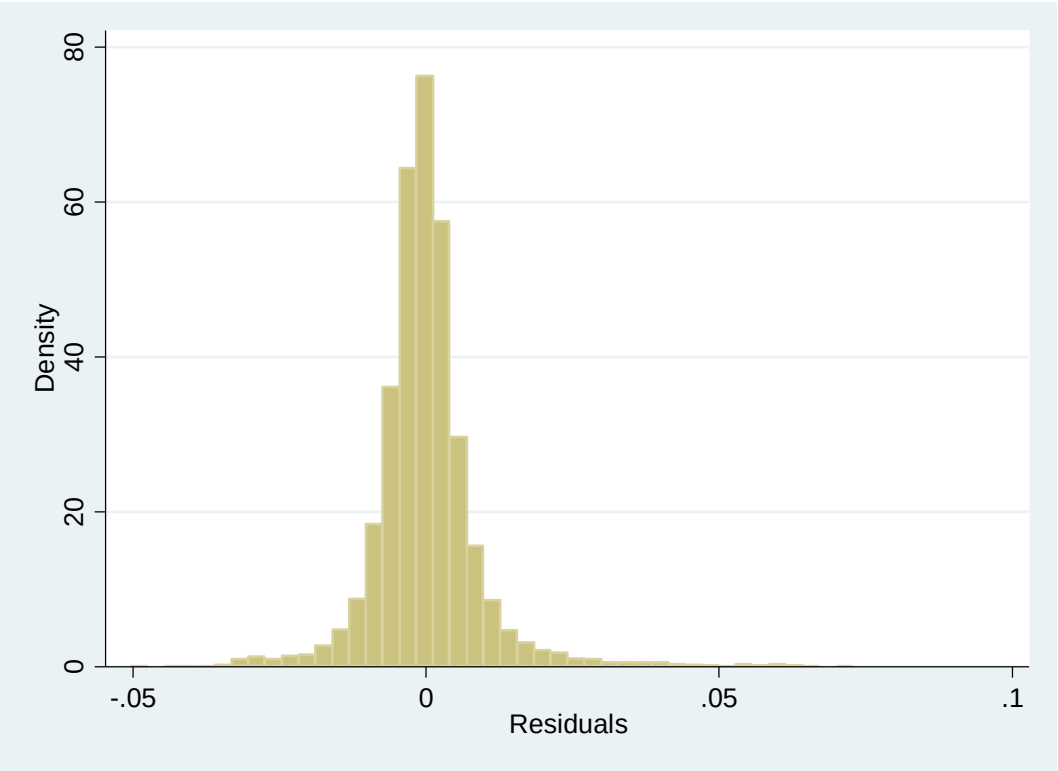
Figure 1. Distribution of Residuals from the Management Earnings Forecast Regressions

Panel A. Forecast Error Residuals



Panel B. Forecast Precision Residuals

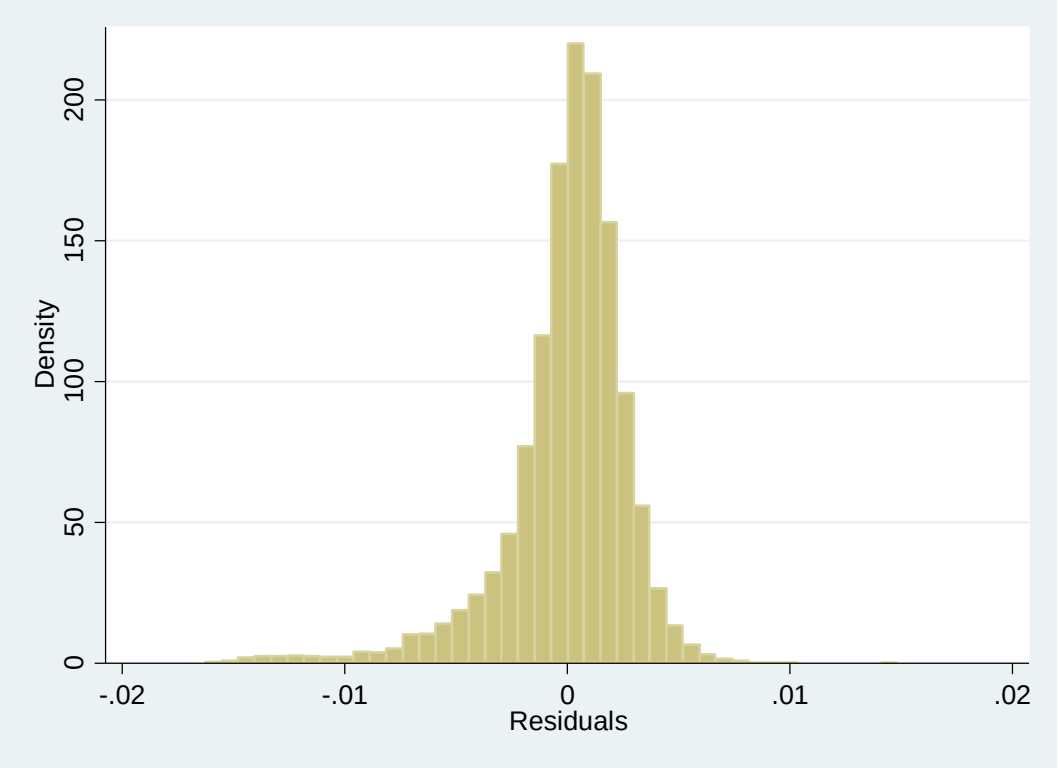


Figure 2. Measures of Investment and Their Relationships

(Compustat acronym is shown in parentheses)

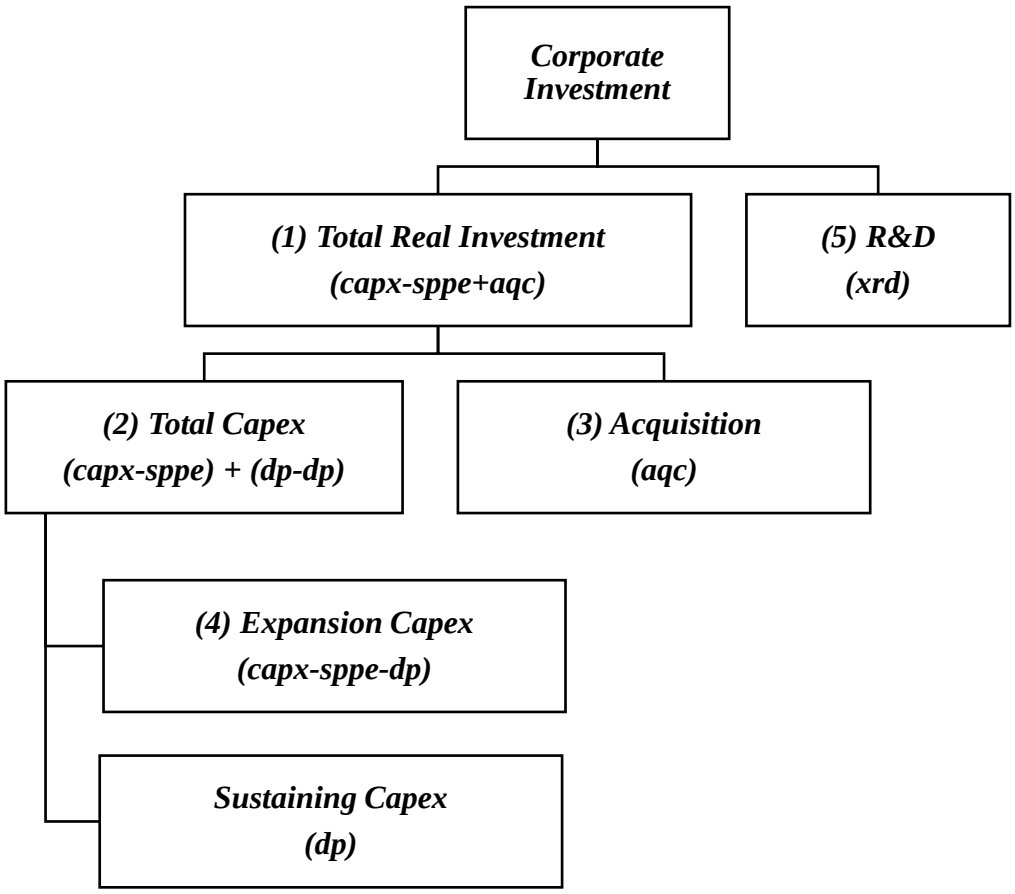


Table 1
Management Earnings Forecasts Sample Selection and Distribution

Panel A. Sample Selection Criteria	
Annual management earnings forecasts for fiscal year 2001 to 2014	66,453
Less: Forecasts that are not point or range estimates	(3,757)
Less: Forecasts not issued within fiscal year t	(6,235)
Total point and range earnings forecasts issued in fiscal year t	56,461
Less: Forecasts unmatched to CRSP-Compustat Merged (CCM) and Execucomp databases	(21,288)
Less: Financial Industry (SIC 6000 – 6999)	(2,649)
Less: Forecasts with missing control variables	(12,224)
Final Sample	20,300

Panel B. Sample Distribution

Forecast Year	Number of Forecasts	Percentage of Yearly Total Forecasts (%)	Proportion of Range Forecasts to Total Forecasts by Year (%)
2001	638	3.14	80.72
2002	1,042	5.13	81.86
2003	1,144	5.64	87.94
2004	1,378	6.79	90.06
2005	1,414	6.97	92.50
2006	1,581	7.79	91.97
2007	1,330	6.55	90.08
2008	1,518	7.48	88.54
2009	1,507	7.42	90.44
2010	1,797	8.85	94.27
2011	1,691	8.33	94.86
2012	1,815	8.94	90.63
2013	1,765	8.69	91.39
2014	1,680	8.28	91.49
Total	20,300	100.00	89.77

Table 2
Management Earnings Forecasts and Firm Characteristics Summary Statistics

This table shows the summary statistics for our dependent variables and firm-level control variables in the management earnings forecast regression. The sample contains 20,300 (18,375) observations for point (range) forecasts and covers 2001 to 2014. Details of all variable measurements are provided in Appendix A.

	N	Mean	Std. Dev.	Min.	Median	Max.
MFE	20,300	-0.000	0.010	-0.037	-0.001	0.070
Precision	18,375	-0.004	0.003	-0.020	-0.003	0.000
Horizon	20,300	195.672	100.026	0.000	200.000	365.000
Firmsize	4,814	7.903	1.476	4.660	7.810	12.491
MB	4,814	3.255	2.895	0.306	2.408	19.435
ROA	4,814	0.068	0.064	-0.311	0.060	0.299
Δ*Earnings*	4,814	0.001	0.078	-0.944	0.006	0.407
Accruals	4,814	-0.056	0.059	-0.348	-0.050	0.134
Earnings Vol	4,814	0.031	0.039	0.001	0.019	0.306
Loss	4,814	0.063	0.243	0.000	0.000	1.000
Independent	4,814	0.755	0.141	0.222	0.778	0.923
Inst. Ownership	4,814	0.763	0.162	0.217	0.785	1.000
HHI	4,814	0.268	0.211	0.042	0.213	1.000
Litigation	4,814	0.241	0.427	0.000	0.000	1.000
MA	4,814	0.217	0.412	0.000	0.000	1.000
Net Equity Issue	4,814	0.031	0.174	0.000	0.000	1.000

Table 3
Management Earnings Forecast Regressions

This table presents the management earnings forecast regression results. The models estimated are discussed in Section 3.1. The sample contains 20,300 (18,375) observations for forecast error (precision) regressions and covers 2001 to 2014. The dependent variables are *MFE* and *Precision*. All control variables are measured at the last fiscal year-end (except for *MA* and *Net Equity Issue*), and details of their measurements are presented in Appendix A. Fama-French 48 Industries by year fixed effects are included. Standard errors are clustered at the firm level. The p-value is reported in parentheses, and ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Constants are not reported.

Independent Variables	Dependent Variables	
	MFE_t	$Precision_t$
$Firmsize_{t-1}$	0.000***	0.000***
	(0.004)	(0.000)
MB_{t-1}	-0.000***	0.000***
	(0.000)	(0.000)
ROA_{t-1}	0.004	0.013***
	(0.204)	(0.000)
$\Delta Earnings_{t-1}$	0.002	0.001
	(0.646)	(0.116)
$Accruals_{t-1}$	0.009***	-0.005***
	(0.003)	(0.000)
$Earnings\ Vol_{t-1}$	0.002	-0.008***
	(0.679)	(0.000)
$Loss_{t-1}$	-0.001	-0.001*
	(0.356)	(0.079)
$Independent_{t-1}$	0.001	-0.001**
	(0.276)	(0.016)
$Inst.\ Ownership_{t-1}$	0.000	0.001*
	(0.703)	(0.074)
HHI_{t-1}	0.001	0.000
	(0.398)	(0.561)
$Litigation_{t-1}$	-0.001	0.001***
	(0.151)	(0.000)
MA_t	0.000	0.000***
	(0.924)	(0.000)
$Net\ Equity\ Issue_t$	-0.003***	0.000
	(0.000)	(0.626)
$Horizon_{t-1}$	0.000***	-0.000***
	(0.000)	(0.000)
Industries by Year Fixed Effect	Yes	Yes
PE Quintiles Fixed Effect	Yes	Yes
Observations	20,300	18,375
Adjusted R^2	0.227	0.338

Table 4
Actual Earnings versus Earnings Forecast Range

This table reports the distribution of actual earnings that fall outside and inside of the earnings forecast range on the full earnings forecasts sample. It further provides breakdowns for earnings forecasts issued by overly precise CEOs and other CEOs. The percentage of the sample total is reported in parentheses. A t-test is conducted to test the difference between the two subsamples. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Full Sample	Overly Precise CEOs	Other CEOs
Outside Range	12,314 (67.0%)	6,503 (71.3%***)	5,811 (62.8%)
Inside Range	6,061 (33.0%)	2,621 (28.7%***)	3,440 (37.2%)
Total	18,375 (100%)	9,124 (100%)	9,251 (100%)

Table 5
Over-Precision and Actual Earnings Outside of Forecast Range

This table presents the logistic regression examining the effect of *optimism* and *over-precision* on the probability of actual earnings falling outside of the forecast range. The sample covers 2001 to 2014. The dependent variables are *OUT* and *OUT Low*. *OUT* is a dummy variable that takes a value of one if the actual earnings fall outside of the forecast range and zero otherwise. *OUT Low* is a dummy variable that takes a value of one if the actual earnings fall below the forecast range and zero otherwise. For brevity, control variables are not reported. All control variables are measured at the last fiscal year-end (except for *MA* and *Net Equity Issue*), and details of their measurements are presented in Appendix A. Fama-French 48 Industry fixed effects and year fixed effects are included. Standard errors are clustered at the firm level. The p-value is reported in parentheses, and ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Constants are not reported.

Independent Variables	Dependent Variables	
	OUT	*OUT Low*
Optimism	-0.077	1.186***
	(0.321)	(0.000)
Over-Precision	0.388***	-0.081
	(0.000)	(0.298)
Firm-level Control Variables	Yes	Yes
Industry Fixed Effect	Yes	Yes
Year Fixed Effect	Yes	Yes
Observations	18,297	18,347
Pseudo R^2	0.064	0.137

Table 6
Regression Results for Persistence of Overconfidence Measures

This table presents the logistic regressions examining the effect of past one- and/or two-year *optimism* and *over-precision* on the current year optimism and over-precision classification. The sample covers 2001 to 2014. The dependent variables are *optimism* and *over-precision* classification in the current year. The independent variables are *optimism* and *over-precision* in year t-1 and/or t-2. Standard errors are clustered at the CEO level. The p-value is reported in parentheses, and ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Constants are not reported.

Independent Variables	Dependent Variables			
	Optimism$_{(t)}$	*Optimism*$_{(t)}$	*Over-Precision*$_{(t)}$	*Over-Precision*$_{(t)}$
Optimism$_{t-1}$	0.898***	0.817***		
	(0.000)	(0.000)		
Optimism$_{t-2}$		0.266**		
		(0.003)		
Over-Precision$_{t-1}$			2.023***	1.806***
			(0.000)	(0.000)
Over-Precision$_{t-2}$				0.706***
				(0.000)
Observations	3,225	2,220	2,934	1,985
Pseudo R^2	0.035	0.036	0.163	0.187

Table 7
CEO Overconfidence and Corporate Investment -- Summary Statistics

This table shows the summary statistics for our dependent variables and control variables in the CEO Overconfidence and Corporate Investment regressions. Panel A summarizes the entire investment sample. Panel B (Panel C) further partitions the sample into optimistic CEO and non-optimistic CEO (overly precise CEO and others) subsamples. A CEO is deemed to be optimistic (overly precise) if the average residuals from the management earnings forecast error (precision) regression are above its corresponding median value. For more details on the classification of optimism and over-precision, refer to Section 3.1. Details of all variable measurements are provided in Appendix A. t-tests are conducted to test for differences between the means for the optimistic and non-optimistic (overly precise and others) subsamples. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Panel A: Pooled sample

	N	Mean	Std. Dev.	Min.	Median	Max.
Dependent Variable						
Total Real Investment	4,168	0.094	0.114	-0.102	0.057	0.737
Total Capex	4,314	0.046	0.045	0.000	0.033	0.317
Acquisition	6,067	0.043	0.094	-0.001	0.005	0.552
Exp. Capex	4,313	0.002	0.047	-0.718	-0.003	0.510
R&D	6,286	0.028	0.045	0.000	0.003	0.254
Independent Variables						
Optimism	6,286	0.470	0.500	0.000	1.000	1.000
Over-Precision	6,286	0.509	0.500	0.000	1.000	1.000
Sales ($m)	6,286	5768.1	11204.0	67.8	2019.5	82559.0
PPE/Emp	6,286	214.2	473.8	2.3	43.0	4327.2
Stock Return	6,286	0.145	0.396	-0.760	0.119	1.749
Tobin's Q	6,286	1.875	1.063	0.739	1.543	7.311
Sales Growth	6,286	0.075	0.170	-0.608	0.073	0.706
Profitability	6,286	0.161	0.086	-0.124	0.147	0.507
Book Leverage	6,286	0.233	0.161	0.000	0.237	0.739
Cash	6,286	0.135	0.163	0.001	0.070	0.847
Delta ($,000)	6,286	649.8	1300.7	6.3	274.7	11572.0
Vega ($,000)	6,286	181.1	243.2	0.0	92.3	1491.3

Table 7
CEO Overconfidence and Corporate Investment Summary Statistics
(Continued)

Panel B: Optimistic versus Non-Optimistic Subsamples

	Optimistic CEOs (610 CEOs)				Non-Optimistic CEOs (612 CEOs)			
Variables	N	Mean	Median	Std. Dev.	N	Mean	Median	Std. Dev.
Dependent Variable								
Total Real Investment	1,940	0.092	0.057	0.112	2,228	0.095	0.057	0.115
Total Capex	1,989	0.047	0.033	0.046	2,325	0.045	0.033	0.043
Acquisition	2,864	0.042	0.004	0.093	3,203	0.044	0.005	0.094
Exp. Capex	1,988	0.002	-0.003	0.046	2,325	0.002	-0.002	0.047
R&D	2,952	0.022***	0.000	0.042	3,334	0.032	0.009	0.047
Independent Variables								
Sales ($m)	2,952	5165.3***	1918.4	9323.4	3,334	6301.8	2061.9	12615.1
PPE/Emp	2,952	213.1	40.7	465.6	3,334	215.1	45.0	481.0
Stock Return	2,952	0.131***	0.100	0.395	3,334	0.157	0.133	0.397
Tobin's Q	2,952	1.736***	1.429	0.973	3,334	1.997	1.672	1.122
Sales Growth	2,952	0.067***	0.062	0.175	3,334	0.083	0.083	0.166
Profitability	2,952	0.162	0.146	0.087	3,334	0.159	0.150	0.085
Book Leverage	2,952	0.254***	0.258	0.159	3,334	0.215	0.208	0.161
Cash	2,952	0.114***	0.056	0.145	3,334	0.153	0.086	0.175
Delta ($,000)	2,952	524.2***	227.8	1015.2	3,334	760.9	329.9	1500.5
Vega ($,000)	2,952	156.0***	84.7	204.2	3,334	203.2	100.1	271.2

Table 7
CEO Overconfidence and Corporate Investment Summary Statistics
(Continued)

Panel C: Overly Precise versus the Remaining Subsamples

	Overly Precise CEOs (615 CEOs)				Non Overly Precise CEOs (607 CEOs)			
Variables	N	Mean	Median	Std. Dev.	N	Mean	Median	Std. Dev.
Dependent Variable								
Total Real Investment	2,176	0.098***	0.059	0.117	1,992	0.089	0.054	0.109
Total Capex	2,273	0.043***	0.032	0.039	2,041	0.049	0.035	0.050
Acquisition	3,065	0.050***	0.007	0.100	3,002	0.036	0.003	0.086
Exp. Capex	2,272	0.002	-0.003	0.041	2,041	0.002	-0.002	0.052
R&D	3,198	0.029**	0.006	0.044	3,088	0.026	0.000	0.046
Independent Variables								
Sales ($m)	3,198	5509.1*	1895.2	10905.4	3,088	6036.2	2178.9	11500.8
PPE/Emp	3,198	173.7***	41.6	382.8	3,088	256.1	44.8	549.4
Stock Return	3,198	0.156**	0.131	0.377	3,088	0.133	0.103	0.414
Tobin's Q	3,198	1.901**	1.612	1.002	3,088	1.847	1.458	1.122
Sales Growth	3,198	0.084***	0.078	0.165	3,088	0.067	0.067	0.176
Profitability	3,198	0.160	0.152	0.075	3,088	0.162	0.140	0.096
Book Leverage	3,198	0.226***	0.233	0.155	3,088	0.241	0.240	0.167
Cash	3,198	0.133	0.063	0.164	3,088	0.136	0.076	0.161
Delta ($,000)	3,198	743.2***	317.7	1470.7	3,088	553.0	237.6	1089.1
Vega ($,000)	3,198	190.7***	99.3	247.0	3,088	171.0	84.5	238.8

Table 8
CEO Overconfidence and Corporate Investment Decisions

This table presents the CEO overconfidence and corporate investment regression results. The models estimated are discussed in Section 4.1.2. The sample covers 2001 to 2014. The dependent variables are *Total Real Investment, Total Capex, Acquisition, Expansion Capex, Acquisition-Expansion Capex* and *R&D*. A CEO is deemed to be optimistic (overly precise) if the average residuals from the management earnings forecast error (precision) regression are above its corresponding median value. For more details on the classification of optimism and over-precision, refer to Section 3.1. All control variables are measured at the last fiscal year-end, and details of their measurements are presented in Appendix A. Fama-French 48 Industry fixed effects and year fixed effects are included. Standard errors are clustered at the firm level. The p-value is reported in parentheses, and ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Constants are not reported.

Independent Variables	Dependent Variables					
	(1) Total Real Investment	*(2) Total Capex*	*(3) Acquisitions*	*(4) Expansion Capex*	*(5) Acquisition.-Exp. Capex*	*(6) R&D*
Optimism	-0.000	-0.001	0.002	-0.001	0.001	0.001
	(0.935)	(0.516)	(0.389)	(0.783)	(0.831)	(0.412)
Over-Precision	0.010**	-0.002	0.009***	-0.000	0.011***	-0.002
	(0.012)	(0.194)	(0.001)	(0.862)	(0.008)	(0.348)
$Log(sales)_{t-1}$	-0.009***	-0.003***	-0.007***	-0.000	-0.006***	-0.003***
	(0.000)	(0.003)	(0.000)	(0.804)	(0.002)	(0.001)
$Log(PPE/Emp)_{t-1}$	0.005**	0.012***	-0.007***	0.005**	-0.011***	0.006***
	(0.041)	(0.000)	(0.000)	(0.012)	(0.000)	(0.000)
$Stock\ Return_{t-1}$	0.018***	0.006***	0.011***	0.002	0.010*	-0.004***
	(0.001)	(0.002)	(0.003)	(0.480)	(0.063)	(0.007)
$Tobin's\ Q_{t-1}$	-0.002	0.002	-0.004	0.007**	-0.011***	0.010***
	(0.521)	(0.189)	(0.108)	(0.016)	(0.009)	(0.000)
$Sales\ Growth_{t-1}$	0.018	0.005	0.016**	0.022***	-0.008	0.007**
	(0.159)	(0.272)	(0.039)	(0.004)	(0.553)	(0.050)
$Profitability_{t-1}$	0.228***	0.119***	0.101***	-0.028	0.130**	-0.084***
	(0.000)	(0.000)	(0.000)	(0.528)	(0.010)	(0.000)
$Book\ Leverage_{t-1}$	-0.035**	-0.044***	-0.000	-0.024***	0.031**	-0.028***
	(0.025)	(0.000)	(0.970)	(0.000)	(0.045)	(0.000)
$Cash_{t-1}$	0.018	-0.021***	0.032**	-0.004	0.039**	0.057***
	(0.350)	(0.000)	(0.032)	(0.651)	(0.039)	(0.000)
$Log(1+delta)_{t-1}$	-0.000	0.001	0.000	0.002	-0.002	-0.002*
	(0.981)	(0.617)	(0.927)	(0.207)	(0.293)	(0.053)
$Log(1+vega)_{t-1}$	0.001	-0.002**	0.002	-0.001	0.003**	0.003***
	(0.678)	(0.035)	(0.152)	(0.121)	(0.044)	(0.000)
Industry Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,168	4,314	6,067	4,313	4,167	6,286
Adjusted R^2	0.118	0.444	0.083	0.206	0.123	0.524

Table 9
CEO Overconfidence and Mergers & Acquisitions – Evidence from Transaction Data

This table presents the logistic regression results on CEO overconfidence and M&A activities. The models estimated are discussed in Section 4.3.1. The sample covers 2001 to 2014. The dependent variables are *MA* and *MA_DIV*. *MA*(*MA_DIV)* is a dummy variable that takes a value of one if the firm conducts at least one M&A (diversifying M&A) transaction during the year and zero otherwise. A CEO is deemed to be optimistic (overly precise) if the average residuals from the management earnings forecast error (precision) regression are above its corresponding median value. For more details on the classification of optimism and over-precision, refer to Section 3.1. All control variables are measured at the last fiscal year-end, and details of their measurements are presented in Appendix A. Fama-French 48 Industry fixed effects and year fixed effects are included. Standard errors are clustered at the firm level. The p-value is reported in parentheses, and ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Constants are not reported.

Independent Variables	Dependent Variables	
	MA	*MA_DIV*
Optimism	0.045	-0.114
	(0.608)	(0.384)
Over-Precision	0.193**	0.302**
	(0.032)	(0.026)
$Log(sales)_{t-1}$	-0.133***	-0.190***
	(0.002)	(0.003)
$Log(PPE/Emp)_{t-1}$	-0.064	-0.150*
	(0.221)	(0.055)
$Stock\ Return_{t-1}$	0.251***	0.276**
	(0.009)	(0.048)
$Tobin's\ Q_{t-1}$	-0.377***	-0.647***
	(0.000)	(0.000)
$Sales\ Growth_{t-1}$	0.791***	0.042
	(0.001)	(0.915)
$Profitability_{t-1}$	1.115*	3.206***
	(0.064)	(0.000)
$Book\ Leverage_{t-1}$	0.009	-0.231
	(0.979)	(0.635)
$Cash_{t-1}$	0.853***	0.568
	(0.006)	(0.184)
$Log(1+delta)_{t-1}$	-0.012	0.096
	(0.786)	(0.182)
$Log(1+vega)_{t-1}$	0.108***	0.100*
	(0.005)	(0.068)
Industry Fixed Effect	Yes	Yes
Year Fixed Effect	Yes	Yes
Observations	6,286	6,185
Pseudo R^2	0.060	0.095

Table 10
CEO Overconfidence and Corporate Financing Decisions

This table presents the logistic regression results for CEO overconfidence and corporate financing activities. The models estimated are discussed in Section 4.4. The sample covers 2001 to 2014. The dependent variables are *Equity Issue*, *Hybrid Issue*, *Debt Issue*, *Net Debt Issue*, and *Net Equity Issue*. A CEO is deemed to be optimistic (overly precise) if the average residuals from the management earnings forecast error (precision) regression are above its corresponding median value. For more details on the classification of optimism and over-precision, refer to Section 3.1. All control variables are measured at the last fiscal year-end, and details of their measurements are presented in Appendix A. Fama-French 48 Industry fixed effects and year fixed effects are included. Standard errors are clustered at the firm level. The p-value is reported in parentheses, and ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively. Constants are not reported.

Independent Variables	Dependent Variables				
	(1) Equity Issue	*(2) Hybrid Issue*	*(3) Debt Issue*	*(4) Net Debt Issue*	*(5) Net Equity Issue*
Optimism	0.017	0.414***	0.052	0.104	-0.107
	(0.906)	(0.006)	(0.577)	(0.153)	(0.574)
Over-Precision	-0.100	-0.157	0.199**	0.233***	-0.048
	(0.485)	(0.282)	(0.030)	(0.002)	(0.790)
$Log(sales)_{t-1}$	-0.035	0.070	0.691***	-0.042	-0.493***
	(0.616)	(0.313)	(0.000)	(0.247)	(0.000)
$Tangibility_{t-1}$	0.382	0.208	0.469	0.209	1.780***
	(0.379)	(0.697)	(0.162)	(0.371)	(0.003)
$Stock\ Return_{t-1}$	0.364**	-0.197	0.011	0.232**	0.569***
	(0.032)	(0.333)	(0.920)	(0.014)	(0.002)
$Tobin's\ Q_{t-1}$	-0.046	0.151	-0.060	-0.067	0.355***
	(0.755)	(0.107)	(0.379)	(0.193)	(0.000)
$Profitability_{t-1}$	-3.369**	-5.925***	0.834	3.032***	-4.240***
	(0.012)	(0.000)	(0.243)	(0.000)	(0.000)
$Book\ Leverage_{t-1}$	3.189***	2.767***	2.961***	0.446	1.681***
	(0.000)	(0.000)	(0.000)	(0.108)	(0.009)
$Log(1+delta)_{t-1}$	0.121	0.146**	0.056	0.070*	0.057
	(0.116)	(0.029)	(0.241)	(0.070)	(0.458)
$Log(1+vega)_{t-1}$	-0.115**	-0.086	0.047	-0.007	-0.027
	(0.043)	(0.170)	(0.200)	(0.812)	(0.669)
Industry Fixed Effect	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes
Observations	6,162	6,046	6,307	6,313	5,403
Pseudo R^2	0.153	0.125	0.206	0.0472	0.143

Internet Appendix A:
Definition of Managerial Optimism and Over-Precision

In the behavioral finance literature, the extant definition of overconfidence is somewhat confusing (Skala 2008). Studies generally focus on two types of overconfidence effects, namely overestimation of the mean and underestimation of the variance.

Overestimation of the mean could arise from overconfidence or optimism, which the psychology literature treats as two different concepts. However, in the behavioral corporate finance literature, they are generally treated the same, given that both overconfidence and optimism lead to overestimation of the mean. For example, Malmendier and Tate (2005) use overconfidence, while Heaton (2002) uses optimism for overestimation of the mean.

Underestimation of the variance stems from another particular type of overconfidence, namely over-precision as defined by Moore and Healy (2008). In the behavioral finance literature, this type of bias is generally referred to as overconfidence (e.g., Gervais, Heaton, and Odean 2011; Goel and Thakor 2008) or miscalibration (Ben-David, Graham, and Harvey 2013). We provide a summary of the definitions that have been used in the table below.

<table>
<tr><th colspan="4"><u>Optimism and Overconfidence in Psychology and Behavioral Finance</u></th></tr>
<tr><th colspan="2">Psychology</th><th colspan="2">Behavioral Finance</th></tr>
<tr><td rowspan="3">Optimism (Larsen and Buss 2002)</td><td>Dispositional Optimism</td><td rowspan="4">Overestimation of the Mean (Optimism in this study)</td><td rowspan="2">Overconfidence (e.g., Malmendier and Tate 2005)</td></tr>
<tr><td>Self-efficacy</td></tr>
<tr><td>Optimistic Bias</td><td rowspan="3">Optimism (e.g., Heaton 2002)</td></tr>
<tr><td rowspan="3">Overconfidence (Moore and Healy, 2008)</td><td>Overestimation</td></tr>
<tr><td>Overplacement</td></tr>
<tr><td>Over-precision</td><td rowspan="2">Underestimation of the Variance (Over-precision in this study)</td><td>Overconfidence (e.g., Goel and Thakor 2008)</td></tr>
<tr><td>Miscalibration (e.g., Ben-David, Graham, and Harvey 2013)</td></tr>
</table>

Overconfidence in the behavioral corporate finance literature could refer to either overestimation of the mean or underestimation of the variance effects. As a result, we use optimism for overestimation of the mean, and over-precision for underestimation of the variance to avoid this confusion.