Investment and Firm Value under High Economic Uncertainty: The Beneficial Effect of Overconfident CEOs

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Abstract

In this paper we investigate whether managerial overconfidence benefits shareholders when economic uncertainty is high. Consistent with managerial overconfidence mitigating the underinvestment problems exacerbated by high economic uncertainty, we find that during periods of import tariff cuts and the global financial crisis, investment and firm value are higher for firms managed by overconfident CEOs than for those managed by non-overconfident CEOs. Moreover, overconfident firms' M&A announcements are associated with more positive abnormal returns when market uncertainty as measured by the CBOE Volatility Index is higher, and overconfident firms are more likely to undertake value-increasing M&A deals.

Keywords: Overconfidence, Risk-aversion, Firm value, Underinvestment, M&A, Economic Uncertainty

JEL classification: D21, D81, G32, G34

Overconfidence is a strong cognitive bias (Christensen-Szalanski and Bushyhead (1981), Alpert and Raiffa (1982), Baumann, Deber, and Thompson (1991)) and managerial trait that significantly affects firm investment. Previous studies show that overconfident managers, who have optimistic assessments of both their own ability and the state of the external environment, systematically overestimate a project's expected return and thus invest more than non-overconfident managers (Malmendier and Tate (2005, 2008), Gervais, Heaton, and Odean (2011), Hirshleifer, Low, and Teoh (2012)). However, while the effect of managerial overconfidence on firm investment is well documented, its effect on firm value is less clear. On the one hand, previous studies have documented an adverse effect of managerial overconfidence on firm value (e.g., Malmendier and Tate (2008), Ho et al. (2016)). On the other hand, a growing number of studies find that external and internal governance mechanisms such as the passage of the Sarbanes-Oxley Act (SOX) (Banerjee, Humphery-Jenner, Nanda (2015)), capital structure (Hackbarth (2008)), boards of directors (Kolasinski and Li (2013)), and optimal compensation contracts (Gervais, Heaton, and Odean (2011)) moderate this negative valuation effect.[1]

The latter studies improve our understanding of the role of governance systems in mitigating the adverse effect of managerial overconfidence. Yet we still know little about the circumstances under which overconfidence becomes a desirable managerial trait that increases firm value. In this study we extend previous literature by identifying high economic uncertainty as a circumstance under which overconfidence becomes a desirable managerial trait. We show that overconfident

[1] For studies that document adverse effects of managerial overconfidence on firm value, see Malmendier and Tate (2008), Hayward and Hambrick (1997), Aktas et al. (2016), and Ho et al. (2016). In contrast, Goel and Thakor (2008) and Campbell et al. (2011) show that optimal optimism leads a risk-averse CEO to choose value-enhancing projects, Hirshleifer, Low, and Teoh (2012) show that firms operating in innovative industries benefit from overconfident CEOs, and Banerjee, Humphery-Jenner, and Nanda (2015) show that while CEO overconfidence has little effect on firm value prior to the passage of the SOX, it helps improve firm value and acquisition performance post-SOX.

CEOs increase firm value during periods of high economic uncertainty by increasing investment to the first-best level required by shareholders.

We begin by developing a model that suggests that managerial overconfidence mitigates the underinvestment problems that a typical risk-averse manager faces during periods of high economic uncertainty. Underinvestment problems intensify during such periods because risk-averse managers have strong incentives to cut investment in existing and new risky projects, including positive-net present value (NPV) projects, to reduce uncertainty about future earnings.[2] Managerial overconfidence helps offset the negative effect of risk-aversion on investment by inducing managers to invest more in positive-NPV projects, moving the level of firm investment closer to its optimal level.[3] Thus, overconfidence can be a valuable managerial characteristic during periods of high economic uncertainty as it can help curb extreme risk-aversion and reduce underinvestment problems.

The rationale for this argument is as follows. Economic uncertainty leads to two significant changes in economic fundamentals: a large increase in the volatility, and a large decrease in the expected value, of product prices and firm productivity. These changes in economic fundamentals affect the optimal levels of firm investment and managerial overconfidence required by

[2] Several studies examine underinvestment problems during periods of high economic uncertainty by focusing on a negative shock to the supply of external finance (Campello, Graham, and Harvey (2010), Duchin, Ozbas, and Sensoy (2010), Ivashina and Scharfstein (2010), Campello et al. (2011)). Duchin, Ozbas, and Sensoy (2010), for example, find that corporate investment declined by 6.4 percent following the 2008 financial crisis, when economic uncertainty was extremely high. The real options literature also suggests that firms become more cautious and have greater incentives to delay investments during periods of high economic uncertainty due to investment irreversibility (e.g., Bernanke (1983), Bloom, Bond, and Van Reenen (2007)). Our study differs from these studies as we focus on how managerial risk-aversion and overconfidence jointly affect underinvestment problems during times of high economic uncertainty.

[3] In line with Campbell et al. (2011), we show that firm value is concave in the level of managerial overconfidence: managers with a moderate level of overconfidence invest optimally, while those with a low (high) level of overconfidence underinvest (overinvest). As economic uncertainty increases, risk-averse managers face incentives to reduce investment, which exacerbates non-overconfident managers' underinvestment problems. However, for overconfident managers, excessive risk-aversion during periods of high economic uncertainty can moderate their tendency to overinvest, resulting in a level of investment that is closer to the optimal level.

shareholders. The idea is that when product prices and firm productivity become volatile, or when firms experience a significant decrease in product prices and productivity, managers who are risk-averse but not overconfident are likely to pass up investment projects (even positive-NPV projects) as they fear the consequences of high uncertainty for their firm's future revenues. Such a reduction in investment is undesirable from the perspective of risk-neutral owners whose optimal level of investment is unaffected by changes in economic uncertainty. In contrast, managers who are risk-averse but optimistic about expected returns on investment projects invest more in risky projects, increasing the investment level closer to the optimum. In sum, during periods of high economic uncertainty, risk-averse managers have strong incentives to reduce investment below the optimal level (Sandmo (1971), Batra (1975)),[4] but managerial overconfidence can alleviate extreme risk-aversion, leading to an increase in investment and firm value. Our model thus predicts that when economic uncertainty is high, overconfident CEOs tend to invest more in positive-NPV projects (or reduce investment less) and perform better than their non-overconfident peers.

To empirically investigate these predictions, we employ several approaches. Using an option-based measure of CEO overconfidence (Malmendier and Tate (2005)) as our primary measure of CEO overconfidence, we first use two quasi-natural experiments (i.e., unexpected industry import tariff cuts and the 2008-2009 global financial crisis) that increase economic uncertainty to test whether firms with overconfident managers invest more and perform better than those with non-overconfident managers when economic uncertainty is high. To the extent that these events are unanticipated, they help address endogeneity of CEO selection prior to the events and establish causality between managerial overconfidence and firm investment (value). Using difference-in-

[4] In our model, we assume that a manager's absolute risk-aversion is decreasing (Pratt (1964), Arrow (1965), Hamal and Anderson (1982)). Decreasing absolute risk-aversion (DARA) suggests that managers behave in a more risk-averse manner when their wealth is reduced. This assumption of DARA is widely used in the literature on the economics of uncertainty (Batra (1975), Sandmo (1977)).

differences analysis and controlling for firm fixed effects, we find that total investment and firm value are higher for firms led by overconfident managers than for firms led by non-overconfident managers following import tariff cuts. Similarly, using a change regression, we find that total investment and firm value are higher for firms managed by overconfident managers than for firms managed by non-overconfident managers during the recent financial crisis. We further find that the positive effect of overconfidence on firm value is more pronounced for firms with higher total investment.

Next, we examine the differential effect of overconfident and non-overconfident managers on investment and firm value in times of high economic uncertainty using an event study approach, where we use merger and acquisition (M&A) announcements as an unexpected corporate event.[5] We find that during periods of high stock market uncertainty as proxied by the Chicago Board Options Exchange (CBOE) Volatility Index (VIX), market reactions to M&A announcements are more positive for firms led by overconfident managers than for those led by non-overconfident managers. Moreover, overconfident CEOs are more likely to undertake value-increasing M&As (i.e., deals with positive announcement returns) than non-overconfident CEOs, suggesting that underinvestment is less severe when overconfident CEOs are in charge during periods of high market uncertainty.

In a third set of tests we further address endogeneity problems by employing two-stage least squares (2SLS) regressions in which we use the local pool of overconfident managers as an instrument for the presence of an overconfident CEO. Our results for investment and firm value do not change.

[5] The VIX is widely used as a measure of market uncertainty in prior literature (e.g., Bhagwat, Dam, and Harford (2016)). The median (mean) VIX over our 1992 to 2015 sample period is 17.68 (19.57). These values surged to 44.93 (45.29) during the 2008-2009 financial crisis, suggesting that the VIX is a good measure of market uncertainty.

To test the robustness of these results, we repeat all of the analyses above using two alternative measures of CEO overconfidence; the first employs a stricter cutoff on CEOs' option-holding behavior and the second is a press-based measure of overconfidence. Our results continue to hold. We also use sudden CEO deaths as an alternative unexpected corporate event. We find that the market's *ex ante* valuation of deaths (especially sudden deaths) of overconfident CEOs is more negative than that of deaths of non-overconfident CEOs.

Overall, our empirical findings are consistent with our model's prediction that firms managed by overconfident CEOs invest more in positive-NPV projects and realize higher firm value than those managed by non-overconfident CEOs during periods of high economic uncertainty.

Our study contributes to the literature in at least two important ways. First, we extend theoretical models that predict the optimal level of CEO overconfidence. Prior studies show that overconfidence can offset risk-aversion and thereby affect firm investment, CEO turnover, capital structure decisions, and firm value (Goel and Thakor (2008), Hackbarth (2008), Campbell et al. (2011), Gervais, Heaton, and Odean (2011)). We extend this literature by considering the role of economic uncertainty, which can exacerbate firms' underinvestment problems. We show theoretically that in times of high economic uncertainty, overconfident managers invest more in positive-NPV projects than non-overconfident managers and thus increase the level of firm investment closer to the first-best level required by shareholders. This result improves our understanding of circumstances under which CEO overconfidence benefits shareholders.

Second, we extend empirical literature that examines the relation between managerial characteristics and corporate outcomes. This literature shows that a high level of managerial overconfidence is associated with inefficient corporate outcomes such as investment (Malmendier and Tate (2005, 2008)), capital structure (Graham, Harvey, and Puri (2013)), and accounting

policies (Schrand and Zechman (2012), Hribar and Yang (2016)). Other studies find that overconfidence is an important determinant of a firm's CEO selection and firing decisions (Goel and Thakor (2008), Campbell et al. (2011)) and optimal compensation contracts (Humphery-Jenner et al. (2016)). We add to this literature by showing that overconfidence can be a valuable CEO trait when economic uncertainty is high, that is, when strong leadership and a commitment to investment are essential for sustainable growth.[6]

The remainder of the paper is organized as follows. In Section I, we develop a model that incorporates managerial overconfidence, risk-aversion, and economic uncertainty, and we discuss testable predictions. In Section II, we describe the data, our key variables, and our identification strategies. In Section III we test the model predictions using tariff cuts and the 2008-2009 financial crisis as quasi-natural experiments, and in Section IV we test the model predictions using M&As as an unexpected corporate event. Section V presents results of robustness tests. Finally, we conclude in Section VI. All proofs are in Appendix A.

I. Simple Model and Empirical Predictions

In this section, we develop a simple model on the relation between economic uncertainty and the optimal level of managerial overconfidence. Our model builds on previous theoretical work and assumes that ownership and control are separated, shareholders are risk-neutral, and managers are risk-averse (Nalebuff and Stiglitz (1983), Goel and Thakor (2008), Campbell et al. (2011)).

[6] In a related paper, Ho et al. (2016) document reckless lending practices of U.S. banks managed by overconfident CEOs in normal economic periods and the negative consequences for bank performance during the 1998 Russian crisis and the 2007-2009 financial crisis. Our study differs from Ho et al. (2016) in two important respects. First, Ho et al. (2016) focus on the consequences of overconfident bank CEOs' pre-crisis investment decisions on bank performance during crisis periods, whereas we examine the effect of managerial overconfidence on firm investment and value during periods of high economic uncertainty. Second, while Ho et al. (2016) restrict their sample to U.S. banks for which strict regulatory requirements preclude overconfident CEOs from expanding investment (i.e., increasing lending) during crisis periods, we conduct our analysis using firms operating in non-regulated industries that are not subject to such constraints.

A. Investment and firm value

We consider a two-period model in which the manager decides how much to invest in a project in period 1 and realizes the return on the project in period 2. With *I* denoting the level of investment, the return on the project is given by $\tilde{z}f(I)$, where $\tilde{z}$ is firm productivity and $f(I)$ is a return function. Firm productivity is a random variable whose value is larger than zero. It is uncertain in period 1 but realized in period 2. The return function is twice-continuously differentiable, strictly increasing, and strictly concave, and it satisfies the conditions $\lim_{I\to 0}\partial f/\partial I = \infty$ and $\lim_{I\to\infty}\partial f/\partial I = 0$. These conditions are necessary to ensure interior investment solutions.

The market price of the firm's product is a random variable such that $\tilde{p} > 0$. Its price is uncertain in period 1 and realized in period 2. We assume that the market price is uncorrelated with productivity (i.e., $\text{cov}(\tilde{p},\tilde{z}) = 0$). Without loss of generality, we assume that the real interest rate is zero. Given that shareholders are risk-neutral, the project's NPV is

$$V(I) = -I + E\tilde{p}\tilde{z}f(I), \tag{1}$$

where E is the expectation operator. The optimal investment level, I^{op}, that maximizes firm value is given by

$$I^{op} = \arg\max_{I>0} V(I). \tag{2}$$

From *Eqs.* (1) and (2), the first-best investment plan is

$$I^{op} = f'^{-1}\left(\frac{1}{E\tilde{p}\tilde{z}}\right). \tag{3}$$

Eq. (3) identifies the factors that affect the optimal level of firm investment, I^{op}. Firm value is maximized when the manager chooses the optimal level of investment. From the perspective of

risk-neutral shareholders, the first-best investment level I^{op} does not vary with changes in the volatility of the market price $\tilde{p}$ or productivity $\tilde{z}$, but rather is affected only by the expected value of $\tilde{p}\tilde{z}$.

B. Managerial overconfidence

Overconfident managers have an optimistic assessment of both their own ability and the state of external conditions and thus overestimate the return on their investment and the market price of the firm's product, which leads them to invest more than non-overconfident managers do.

A manager's subjective return is given by

$$(1+A)\tilde{p}\tilde{z}f(I), \tag{4}$$

where *A* is a relative measure of overconfidence such that positive, zero, and negative values of *A* indicate that the manager overestimates, correctly estimates, and underestimates returns, respectively, and $\tilde{p}\tilde{z}f(I)$ is the realized return on investment. The manager maximizes her subjective utility based on the estimated return, which is determined by her level of overconfidence (*A*).

C. Managers' preferences and investment decisions

Following Selden (1978) and Epstein and Zin (1989), we define the manager's time and risk preferences separately. The manager's time preference is the same as that of shareholders, namely, the linear preference shown in *Eq.* (1). The manager's risk preference, $u(\cdot)$, however, is different from that of shareholders, which is homogeneous, twice-continuously differentiable, strictly increasing, and strictly concave. The certainty-equivalent of the manager's second-period reward is

$$u^{-1}Eu\left(\tilde{p}\tilde{z}f(I)\right), \tag{5}$$

and her subjective utility (*M*) is

$$M(I) = -I + u^{-1}Eu\left((1+A)\tilde{p}\tilde{z}f(I)\right). \tag{6}$$

It follows from *Eq.* (6) that the manager's utility-maximizing choice of investment is

$$I^{*} = f^{'-1}\left(\frac{1}{(1+A)u^{-1}E u\tilde{p}\tilde{z}}\right). \tag{7}$$

The manager's investment decision in *Eq.* (7) indicates that overconfident managers (i.e., managers with a high level of *A*) choose a higher level of investment than non-overconfident managers (i.e., managers with a low level of *A*). The following lemma summarizes this relation between managerial overconfidence and firm investment.

Lemma 1. *For a given level of economic uncertainty, if different managers have overconfidence levels* A_l *and* A_h *, where* $A_l < A_h$*, then managers with* A_h *invest more than those with* A_l*.*

Proof. See Appendix A.

D. Optimal level of managerial overconfidence during periods of high economic uncertainty

When economic uncertainty is high, product prices and firm productivity become more volatile. For example, an import tariff reduction lowers entry barriers to domestic product markets, which invites more foreign rivals into the local market (Frésard and Valta (2016)). The resulting increase in industry competition increases uncertainty about both product prices and firm productivity. Similarly, market-wide shocks such as the 2008-2009 global financial crisis have a highly negative effect on asset prices, firm production, and investor sentiment, leading to increased volatility in the market (Rachedi (2014)).

To incorporate changes in the volatility of product prices and firm productivity during periods of high economic uncertainty into our model, we assume that the market price of the firm's product $\tilde{p}$ can be decomposed into certain and uncertain components as follows:

$$\tilde{p} = p + \sigma\tilde{q}, \tag{8}$$

where p and σ are the expected value and the standard variation of the market price, respectively, and $\tilde{q}$ is a random variable satisfying $E[\tilde{q}] = 0$ and $var[\tilde{q}] = 1$. Similarly, we assume that productivity $\tilde{z}$ can be decomposed into certain and uncertain components, as follows:

$$\tilde{z} = z + \rho\tilde{r}, \tag{9}$$

where z and ρ are the expected value and the standard variation of productivity, and $\tilde{r}$ is a random variable satisfying $E[\tilde{r}] = 0$ and $var[\tilde{r}] = 1$. Because we assume that productivity and the market price of the firm's product are uncorrelated, we have $\mathrm{cov}(\tilde{q}, \tilde{r}) = 0$.

From *Eqs.* (3), (7), (8), and (9), the optimal level of managerial overconfidence A^+ that maximizes firm value is given by

$$A^+ = \frac{E\tilde{p}\tilde{z}}{u^{-1}Eu\tilde{p}\tilde{z}} - 1 = \frac{Epz}{u^{-1}Eu\left(pz + \sigma\tilde{q} + \rho\tilde{r} + \tilde{q}\tilde{r}\right)} - 1, \tag{10}$$

which is positive for any non-degenerate random variable $\tilde{p}\tilde{z}$. *Eq* (10) indicates that when both the market price of the firm's product and firm productivity are certain, $E\tilde{p}\tilde{z}$ is equal to $u^{-1}Eu\tilde{p}\tilde{z}$ and thus the optimal level of managerial overconfidence is zero. However, when the market price and productivity are uncertain, the optimal level of managerial overconfidence is strictly positive, which can be verified using Jensen's inequality.

As in Campbell et al. (2011), a manager with a moderate level of overconfidence, A_m, (i.e., A^+ in *Eq.* (10)) chooses the first-best investment level. Because firm value is concave in the level of

managerial overconfidence, managers whose confidence is below (above) the moderate level, A_l (A_h), underinvest (overinvest).

We investigate whether changes in price volatility during periods of high economic uncertainty differentially affect the value of firms with overconfident and non-overconfident managers. As product prices become more volatile (i.e., an increase in σ in *Eq.* (8)), the volatility of the project's payoff, $\tilde{p}\tilde{z}f(I)$, increases, which reduces a risk-averse manager's utility. Risk-averse managers attempt to improve their utility by reducing investment, which decreases the volatility of the project's payoff. However, this tendency to reduce investment during periods of high economic uncertainty has different valuation effects depending on the manager's level of overconfidence: non-overconfident managers face severe underinvestment problems due to their excessive risk-aversion, while overconfident managers face less severe underinvestment problems as their excessive risk-aversion is offset by their overinvestment tendency arising from overconfidence, resulting in higher firm value for firms with overconfident managers.

The valuation effects of an increase in price volatility for firms led by overconfident managers and for firms led by non-overconfident managers are summarized in Proposition 1 as follows.

Proposition 1. *As the market price of the firm's product becomes more volatile (i.e., σ increases), the optimal level of managerial overconfidence* (A^+) *increases. Thus, the value of firms with overconfident managers* (A_h) *is higher than that of firms with non-overconfident managers* (A_l) *for any level of price volatility $\sigma > \bar{\sigma}$, where $\bar{\sigma}$ is positive.*[7]

Proof. See Appendix A.

[7] The parameter $\bar{\sigma}$ is the level of price volatility at which the value of firms with overconfident managers (A_h) is the same as the value of firms with non-overconfident managers (A_l).

Proposition 1 indicates that although an increase in price volatility leads to excessive risk-aversion and reduced investment, managerial overconfidence can move a firm's investment closer to its first-best level. Thus, firms led by overconfident managers enjoy higher value than those led by non-overconfident managers, as overconfident managers invest more than non-overconfident managers (see Lemma 1) and thus face lower underinvestment problems.

We also investigate whether changes in the volatility of firm productivity during periods of high economic uncertainty differentially affect the value of firms with overconfident and non-overconfident managers. Firm productivity becomes more volatile during periods of high economic uncertainty, which increases the volatility of the marginal benefit of investment and thus makes investment unattractive for risk-averse managers. Following a similar argument as above, managerial overconfidence again plays a value-enhancing role by curbing extreme risk-aversion during periods of high economic uncertainty and inducing managers to invest more in positive-NPV projects.

The valuation effects of an increase in the volatility of firm productivity for firms led by overconfident managers and for firms led by non-overconfident managers are summarized in Proposition 2 as follows.

Proposition 2. *As firm productivity becomes more volatile (i.e., ρ increases), the optimal level of managerial overconfidence (A^+) increases. Thus, the value of firms with overconfident managers (A_h) is higher than that of firms with non-overconfident managers (A_l) for any level of productivity volatility $\rho > \overline{\rho}$, where $\overline{\rho}$ is positive.*

Proof. See Appendix A.

In Appendix B, we further develop a model in which we examine how the expected values of product prices and firm productivity affect the optimal level of managerial overconfidence during periods of high economic uncertainy. We show that both investment and firm value are higher for firms led by overconfident managers than for firms led by non-overconfident managers when expected product prices and firm productivity decrease during periods of high economic uncertainty.

In sum, Propositions 1 and 2 indicate that as the volatility of product prices and firm productivity increase during periods of high economic uncertainty, risk-averse managers choose a level of investment that is below the optimal level (of risk-neutral shareholders), which reduces firm value. However, this underinvestment problem during periods of high economic uncertainty is less severe in firms managed by overconfident CEOs who overestimate the expected return on investment and as a result invest more relative to their non-overconfident counterparts. Therefore, these propositions suggest that compared to firms led by non-overconfident CEOs, those led by overconfident CEOs invest more when economic uncertainty is high, which leads to better firm performance.

II. Data, Variable Construction, and Summary Statistics

A. Sample

We use several samples to examine how managerial overconfidence affects firm investment and value during periods of high economic uncertainty. We start with the universe of firms covered in ExecuComp, which provides detailed information on CEOs, including data on option compensation that are required to construct our primary measure of CEO overconfidence. We then

exclude firms operating in regulated industries (Standard Industrial Classification (SIC) codes 4900 to 4999 and 6000 to 6999).

In our first set of tests we use two unanticipated events that exogenously increase economic uncertainty: changes in import tariffs in manufacturing industries (SIC codes 2000 to 3999) from 1992 to 2005 and the 2008-2009 global financial crisis. Using these unexpected industry- and economy-level events allows us to sidestep concerns surrounding the endogeneity of CEO selection and better establish causality between managerial overconfidence and firm investment (value) during periods of high economic uncertainty. For example, because shareholders are not likely to foresee these uncertainty-increasing events, they are not likely to proactively hire CEOs with certain characteristics (e.g., overconfidence) that can help the firm cope with the increase in uncertainty. Similarly, while it is possible that firms with good performance are more likely to hire overconfident CEOs, so that firms led by overconfident CEOs have a higher Tobin's *q*, using unexpected economic events alleviates this concern. The samples in these analyses contain 1,133 firms (8,547 firm-year observations) and 1,004 firms as of fiscal year 2007, respectively.

Next, we conduct event study analyses using unexpected M&A announcements. We obtain data on M&A deals from the U.S. Mergers and Acquisitions database of the Securities Data Corporation (SDC). Our sample includes all completed M&As from 1992 to 2016 that meet the following selection criteria: 1) the deal value disclosed in SDC is greater than $1 million and is at least 1% of the acquirer's market value of equity measured on the 11th trading day prior to the announcement date, and 2) the acquirer controls less than 50% of the target's shares prior to the announcement and owns 100% of the target's stock after the transaction. These restrictions result in a sample of 3,050 completed M&A deals by 1,314 firms.

Although reverse causality is not likely to be a concern in our empirical settings, it is possible

that unobservable omitted firm characteristics simultaneously affect both the selection of overconfident CEOs and firm investment (value), resulting in a spurious correlation between the two. Our test design in the analyses above (difference-in-differences tests, regressions with firm fixed effects, and change regressions) helps address this concern, but as a further test we employ 2SLS in which we use the local supply of potential overconfident CEOs as an instrument for the presence of overconfident CEOs. We discuss the construction of this instrument and its validity in detail in Section V. We conduct our 2SLS regression analysis using all non-regulated firms (2,550 unique firms, for 26,232 firm-year observations) covered in ExecuComp from 1992 to 2015.

We obtain financial and stock return data from Compustat and the Center for Research in Security Prices (CRSP), respectively, and state-level data from the U.S. Bureau of Economic Analysis (BEA). We obtain data on a CEO's scaled wealth-performance sensitivity, which is available from 1992 to 2009, from Edmans, Gabaix, and Landier (2009).

B. Variable construction

Following prior studies, we use an option-based measure of optimism as our primary measure of CEO overconfidence (Malmendier and Tate (2005), Campbell et al. (2011), Hirshleifer, Low, and Teoh (2012), Humphery-Jenner et al. (2016)). We consider a CEO as overconfident if she postpones the exercise of vested options that are more than 67% in the money for two or more years to capture a "permanent" effect. A CEO is classified as overconfident from the first year she exhibits such option-holding behavior. In robustness tests, we use an alternative option-based measure of CEO overconfidence that takes the value of one if the CEO postpones the exercise of vested options that are more than 100% in the money at least twice, and zero otherwise (Campbell et al. (2011)). We also use a press-based measure of CEO overconfidence (Malmendier and Tate

(2008), Hirshleifer, Low, and Teoh (2012), Banerjee, Humphery-Jenner and Nanda (2015)), which is calculated as the logarithm of one plus the difference between the number of news articles that use "confident" terms and the number of news articles that use "cautious" terms.[8]

C. Summary statistics

Panel A of Table I reports the distribution of overconfident and non-overconfident firms by industry. The sample consists of all non-regulated firms (26,232 firm-year observations) covered in ExecuComp from 1992 to 2015. Overconfident firms are those managed by overconfident CEOs who postpone the exercise of vested options that are more than 67% in the money at least twice. These firms account for 52.38% of the sample. Overconfident firms are distributed fairly evenly across industries, although their presence is somewhat higher in the mineral and construction industries and somewhat lower in the agriculture, forestry, and fisheries industries.

Panel B of Table II provides summary statistics for the sample firms. We winsorize all continuous variables at the 1% level in both tails to mitigate the effects of potential outliers. We find that compared to non-overconfident firms, overconfident firms are smaller and younger and they have higher tangible assets and lower leverage. Overconfident firms also have higher cash flow to total assets, Tobin's *q*, capital expenditures, sales growth, stock return volatility, and institutional block ownership than non-overconfident firms. Turning to CEO characteristics, overconfident CEOs have higher scaled wealth-performance sensitivity of CEO compensation (Edmans, Gabaix, and Landier (2009)) than non-overconfident CEOs, suggesting that their

[8] We thank Suman Banerjee for sharing the hand-collected press-based measure of overconfidence used in Banerjee, Humphery-Jenner, and Nanda (2015) with us. They search articles reporting on CEOs of firms in ExecuComp from the period 2000 to 2006 in major newspapers including *New York Times*, *Business Week*, and *Economist*. The terms that they search over are "overconfident or overconfidence," "optimistic or optimism," "reliable," "cautious," "conservative," "practical," "frugal," and "steady."

compensation is more closely tied to firm performance. Overconfident CEOs are also older and more likely to serve as chair of the board, and they have longer tenure than their counterparts. The differences in firm and CEO characteristics between overconfident and non-overconfident firms are all significant at 1% level. Appendix C provides detailed descriptions of the variables used in Table I.

III. Overconfident CEOs, Investment, and Firm Value: Using Quasi-natural Experiments that Exogenously Increase Economic Uncertainty

In this section, we use two quasi-natural experiments – industry import tariff cuts and the 2008-2009 global financial crisis – to test our model predictions that firms with overconfident managers invest more and perform better than those with non-overconfident managers when economic uncertainty is high. Using industry import tariff cuts and the recent financial crisis has two important advantages. First, unlike an increase in firm-specific uncertainty, which is endogenous and hence could be an outcome of a firm's investment decisions and performance, an increase in uncertainty caused by these industry- and economy-wide shocks is exogenous and likely to be orthogonal to these firm-specific characteristics. Second, these events are largely unexpected and thus, as we discuss in Section II, it is unlikely that shareholders proactively hire overconfident CEOs, which would raise questions about the direction of causality in the relation between managerial overconfidence and firm investment (value). Thus, our empirical settings allow us to sidestep concerns related to potential endogeneity of CEO selection and reverse causality.

A. Difference-in-differences tests using unexpected changes in import tariffs

In a first set of tests, we use industry-level import tariff cuts to examine the effect of managerial overconfidence on firm investment and value during periods of high economic uncertainty. Prior studies use tariff reductions that lead to an increase in competition from foreign competitors as an exogenous event that triggers changes in the industry's competitive landscape (e.g., Frésard and Valta (2016)). Reduced import tariffs increase the supply of goods and services from foreign rivals in domestic markets, and thus significantly intensify competitive pressure on domestic manufacturers, resulting in an increase in the volatility of product prices and firm productivity and a decline in average product prices.

To compare overconfident and non-overconfident firms' change in investment in response to an unexpected reduction in industry-level import tariffs,[9] we estimate the following difference-in-differences regression with firm fixed effects:

$$\Delta\text{Total investment}_{it} = \beta\text{Tariff cut}_{it}\text{ (indicator)} + \gamma\text{Tariff cut}_{it}\text{ (indicator)} \times \text{Overconfident CEO}_{jit}\text{ (indicator)} + \mu X_{jit} + \psi Y_{it} + \rho_t + \iota_i + \varepsilon_{it}, \quad (11)$$

where *j*, *i*, and *t* index CEOs, firms, and year, respectively. Δ*Total investment* is the change in the ratio of a firm's total investment (sum of capital, R&D, and acquisition expenditures) to total assets from year *t-1* to year *t*. *Tariff cut* is an indicator that takes the value of one if an industry in which a firm operates experienced a tariff cut in the last two years (i.e., year *t* and *t-1*), and zero otherwise.[10] *Overconfident CEO* is an indicator that takes the value of one if the CEO postpones

[9] See, for example, Frésard (2010), Valta (2012), Dasgupta, Li, and Wang (2014), and Frésard and Valta (2016), who use tariff reductions to address endogeneity problems inherent in their studies.

[10] We use U.S. import data at the four-digit SIC code level compiled by Frésard and Valta (2016) to construct *Tariff cut*. Specifically, we first identify tariff reductions using the deviation in the yearly change in tariff rate from the industry's median. We then identify all industries in which the largest tariff rate reduction is three times larger than the median tariff rate reduction in that industry. We exclude tariff cuts that are preceded or followed by equally large increases in tariff rates to ensure that tariff cut events reflect non-transitory changes in an industry's competitive environment.

the exercise of vested options that are more than 67% in the money at least twice, and zero otherwise. X_{jit} is a vector of characteristics describing CEO *j* at firm *i* in year *t:* CEO-chair duality, tenure, age, and wealth-performance sensitivity. We control for CEO wealth-performance sensitivity (Edmans, Gabaix, and Landier (2009)) as previous studies show that CEOs whose compensation is tied to performance take on more risk compared to those who do not have such plans. For example, Guay (1999), Datta et al. (2001), and Coles, Daniel, and Naveen (2006) show that stock options encourage managers to take value-increasing risky projects and thus counter managerial risk-aversion. Y_{it} is a vector of characteristics describing firm *i* in year *t* (e.g., Almeida and Campello (2007)): firm size (log (sales)), age, asset tangibility, profitability (cash flow / total assets), leverage, and Tobin's *q*. ρ_t and ι_i are year and firm fixed effects, respectively, which control for potential time trends and mitigate the concern that unobservable time-invariant firm characteristics drive our results. ε_{it} is an error term. In specification (1), our key independent variable of interest in the interaction term between *Tariff cut* and *Overconfident CEO*. The coefficient on this interaction, γ, is the difference in *Total investment* between overconfident and non-overconfident firms during periods of high economic uncertainty and hence captures the effect of managerial overconfidence on investment during such periods. Lemma 1 predicts a positive and significant γ. Standard errors are adjusted for heteroskedasticity and clustered at the firm level.

To examine the valuation effect of managerial overconfidence during periods of high economic uncertainty, we replace Δ*Total investment* in specification (11) with the change in Tobin's *q* from year *t-1* to year *t* (Δ*Tobin's q*). Here, Y_{it} is a vector of characteristics describing firm *i* in year *t-1* that are likely to affect firm value: firm size (log (sales), age, leverage, profitability (cash flow / total assets), investment (capital expenditures / total assets), growth opportunities

(sales growth), risk (stock return volatility), and corporate governance (institutional block ownership). Propositions 1 and 2 predict a positive and significant γ.

Panel A of Table II reports results of difference-in-differences regressions in which the dependent variable is Δ*Total investment*. In column (1), we find that the coefficient on *Tariff cut* is negative and insignificant and that on the interaction term between *Tariff cut* and *Overconfident CEO* is positive and significant at the 5% level. The coefficient of 2.510 on the interaction term between *Tariff cut* and *Overconfident CEO* suggests that the *Total investment* of firms managed by overconfident CEOs is 2.5% higher than that of firms managed by non-overconfident CEOs when they experience unexpected changes in industry competition. Given that the unconditional mean Δ*Total investment* for the full sample is -0.11%, this increase is economically large and significant. In column (2), we replace firm fixed effects with industry fixed effects and find that the results are almost identical except that the coefficient on *Tariff cut* becomes significantly negative at the 1% level. Overall, these results suggest that firms with overconfident CEOs invest more than those with non-overconfident CEOs when uncertainty is heightened by industry-level shocks, in line with the prediction of Lemma 1.

Panel B of Table II reports results of difference-in-differences regressions in which the dependent variable is Δ*Tobin's q*. In column (1), we estimate the regression controlling only for firm and year fixed effects. We find that the coefficient on the interaction term between *Tariff cut* and *Overconfident CEO* is positive and significant at the 5% level, suggesting that firm value is higher for firms with an overconfident CEO than for those with a non-overconfident CEO during periods of high economic uncertainty. In column (2), we include the firm- and CEO-level control variables and find that the coefficient on the interaction term between *Tariff cut* and *Overconfident CEO* is positive and significant at the 1% level. The coefficient estimate of 0.366 suggests that

Tobin's *q* is 36.6 percentage points higher for overconfident CEO firms than for non-overconfident firms when tariff rates are reduced. Given that the unconditional sample mean change in Tobin's *q* for the full sample is -0.039, this result is economically large and significant. In columns (3) and (4), we divide the sample according to the sample median Δ*Total investment* and reestimate the regressions in column (2) separately for these two subsamples. We find that the coefficient on the interaction term between *Tariff cut* and *Overconfident CEO* is positive and significant only in column (3) (i.e., high Δ*Total investment* subsample).[11] Thus, the positive valuation effect of managerial overconfidence on firm value in periods of high economic uncertainty is more pronounced among firms that invest more, suggesting that investment is a potential channel through which firms with an overconfident CEO create value. These results are consistent with the predictions of Propositions 1 and 2.

B. Tests using the 2008-2009 financial crisis

In a second set of tests, we use the 2008-2009 financial crisis as a largely unanticipated exogenous shock that significantly increases economic uncertainty (e.g., Lins, Volpin, and Wagner (2013)). To examine differences in investment tendency and firm value between overconfident CEOs and non-overconfident CEOs during the crisis period, we limit attention to firms with data available in fiscal year 2007, a year before the crisis. To minimize the concern that investment policy during the crisis can be affected by a change in management, we require that firms not experience a CEO turnover in 2007 and 2008. Our key independent variable of interest is *Overconfident CEO*.

[11] A test of the difference in coefficients on the interaction term between *Tariff cut* and *Overconfident CEO* across high and low Δ*Total investment* firms can be performed only when we use industry fixed effects. We find that the difference is not significant when we estimate the regressions using industry fixed effects.

In Panel A of Table III, we regress Δ*Total investment* (change in average *Total investment* from the pre-crisis period (Q1 and Q2 of 2008) to the crisis period (Q4 of 2008 and Q1 of 2009)) on the change in firm-level variables (change in average firm characteristics from the pre-crisis period to the crisis period) and CEO characteristics as of 2007. We require that information on firms' quarterly total investment be available for all four quarters. Consistent with the prediction of Lemma 1, we find that the coefficient on *Overconfident CEO* is positive and significant at the 5% level in both columns (1) and (2). Given that the unconditional mean Δ*Total investment* for the full sample is 1.47%, the coefficient estimate of 0.721 on *Overconfident CEO* in column (2) accounts for almost 50% of the mean change.

Panel B of Table III presents estimates of OLS regressions in which the dependent variable is industry-adjusted buy-and-hold returns during the crisis period (from August 1, 2008 to March 31, 2009). The industry-adjusted buy-and-hold return is computed as the difference between a firm's buy-and-hold return and the industry median return for firms in the same two-digit SIC code. In column (1), we control only for the firm characteristics used in Panel B of Table II. Consistent with the predictions of Propositions 1 and 2, we find that industry-adjusted buy-and-hold returns during the crisis period are 5.2 percentage points higher for overconfident CEO firms than for non-overconfident CEO firms. This valuation effect is economically large and significant given that the mean industry-adjusted buy-and-hold return for the full sample during the crisis is 0.62%.[12] We also find that firms that have low leverage, high cash flow, and less risk prior to the crisis outperform during the crisis. In column (2), we control for industry-adjusted pre-crisis stock returns, which are measured by subtracting the median buy-and-hold return for other firms in the two-digit SIC code from the focal firm's buy-and-hold return during the pre-crisis period (from

[12] The mean raw buy-and-hold return for the full sample is -39%.

December 1, 2007 to July 31, 2008)), and find that the results do not change. In column (3), we further control for CEO-level characteristics including CEO wealth-performance sensitivity, CEO-chair duality, CEO tenure, and CEO age and find that the coefficient on *Overconfident CEO* remains positive and significant. To examine whether the relative outperformance of overconfident CEO firms during the crisis period is driven by their larger investment during the same period, we divide the sample according to the sample-median Δ*Total investment* from the pre-crisis period to the crisis period (i.e., quarterly average *Total investment* in the crisis period (Q4 of 2008 and Q1 of 2009) minus quarterly average *Total investment* in the pre-crisis period (Q1 and Q2 of 2008)). The results are reported in columns (4) and (5). Consistent with the prediction of our model, we find that the coefficient on *Overconfident CEO* is positive and significant only among the high Δ*Total investment* subsample, which suggests that firms managed by overconfident CEOs outperform those managed by non-overconfident CEOs only when they increase their investment during the height of the financial crisis.

Although we control for firm- and CEO-level characteristics in the regressions and use change regressions to alleviate the concern that unobservable omitted firm characteristics derive our results, it is still possible that some pre-crisis firm characteristics such as leverage and performance simultaneously affect the presence of overconfident CEOs and a firm's ability to invest and cope with a financial shock. To mitigate this concern, in untabulated tests, we conduct a propensity score matching analysis using firm-level characteristics used in column (1) of Panel A (column (2) of Panel B) as matching criteria. To find optimal matches, we use three different matching techniques: nearest neighborhood, Gaussian kernel, and local linear regression. We conduct matching with replacement and drop 2% of observations for which the propensity score density of the matched observations is the lowest (Smith and Todd (2005)). We use bias-corrected 95%

confidence intervals with bootstrapping based on 50 replications to infer statistical significance. We find that the average differences in *Total investment* (industry-adjusted buy-and-hold returns) between overconfident CEO firms and matching non-overconfident CEO firms are 0.68-0.83 (0.05) percentage points, which are significant at the 5% level (5% level or better). These findings help address the concern that pre-crisis firm characteristics may drive our findings in Table III.

IV. Overconfident CEOs, Investment, and Firm Value: Using an Event Study Approach

In this section, we test the predictions of our model using M&A announcements, an unexpected corporate event. M&As are an ideal setting to investigate the effect of CEO overconfidence on firm value as they are among the most important corporate investment decisions a firm can make, with a significant effect on firm value.[13] Moreover, M&As are largely unexpected events, which helps mitigate the concern of reverse causality in the relation between managerial overconfidence and firm value. Our model predicts that when economic uncertainty is high, overconfident CEOs are more likely to avoid underinvestment problems than non-overconfident CEOs, and thus their investments have a more positive effect on firm value.

In Panel A of Table IV, we examine whether market reactions differ between M&As announced by overconfident CEOs and those announced by non-overconfident CEOs. The dependent variable is the cumulative abnormal return of the acquirer from one day before to one day after the announcement date (CAR (-1, 1)). To calculate the abnormal return, we use the

[13] Malmendier and Tate (2008) use mergers as a setting in which to examine the effect of CEO overconfidence on firm value. Our study differs from Malmendier and Tate (2008) in that we focus on circumstances (i.e., periods of high economic uncertainty) under which managerial overconfidence has an incremental positive effect on firm value. It should be noted that our results are not directly comparable to their results, for several reasons. First, our sample of M&A deals by firms included in ExecuComp and SDC over the 1993 to 2016 period overlap little with their sample mergers by firms included in the *Forbes* list over the 1984 to 1994 period. Second, our sample excludes M&As by firms operating in regulated industries, while Malmendier and Tate (2008) include these deals. Third, we calculate the average moneyness of a CEO's option portfolio following Campbell et al. (2011), while Malmendier and Tate (2008) use actual data on CEO option holdings and exercise prices for each option grant.

market model with parameters estimated over 220 trading days of return data that end 60 days before the M&A announcement. We use the CRSP value-weighted return as a proxy for the market return. Our key independent variable of interest is the interaction term between *Overconfident CEO* and *High uncertainty*, where *High uncertainty* is an indicator that takes the value of one if the last closing price of the VIX prior to the M&A announcement date is above the sample median and zero otherwise. In addition to the controls for firm- and CEO-specific characteristics used in our previous analyses, we include several bidder and deal characteristics in the regressions following prior literature (e.g., Masulis, Wang, and Xie (2007)).

In column (1), we find that the coefficient on the interaction term between *High uncertainty* and *Overconfident CEO* is positive and significant at the 5% level after controlling for various firm-, CEO-, and deal-specific characteristics. Thus, during periods of high market uncertainty, shareholders of acquirers with an overconfident CEO realize higher returns than those of acquirers with a non-overconfident CEO. The coefficient estimate of 0.963 on the interaction term suggests that M&As by firms with an overconfident CEO have a 0.96% higher CAR (-1, 1) than M&As by firms with a non-overconfident CEO. This finding is economically large and significant given that the mean CAR (-1, 1) for the full sample is -0.19%. In column (2) we find that our results do not change, although including CEO wealth-performance sensitivity as an additional control variable reduces the sample size from 3,050 to 2,367. These results are consistent with the predictions of Propositions 1 and 2.

In Panel B of Table IV, we examine whether overconfident CEOs are more likely to avoid underinvestment problems than non-overconfident CEOs during periods of high market uncertainty. Following Mitchell and Lehn (1990), we assume that an M&A deal with a positive stock market reaction is a value-increasing investment and construct an indicator that takes the

value of one if the acquirer CAR (-1, 1) is positive and zero otherwise. We then estimate probit regressions using this indicator as the dependent variable. In columns (1) and (2), we find that the coefficient on the interaction term between *High uncertainty* and *Overconfident CEO* is positive and significant at the 1% level, suggesting that acquirers with overconfident CEOs are more likely to undertake value-increasing acquisitions than non-overconfident CEOs when market volatility is high.

Overall, the results in this subsection provide additional evidence in support of the model's prediction that managerial overconfidence curbs extreme risk-aversion during periods of high economic uncertainty: investments made by overconfident CEOs are associated with higher firm value than those made by non-overconfident CEOs, and firms with overconfident CEOs invest more in value-increasing projects (i.e., lower underinvestment problems).

V. Robustness Tests

To check the robustness of our results, we conduct several additional tests. Below, we briefly summarize the results of these tests.

A. Instrumental variables analysis using the full sample

While using a difference-in-differences approach around unexpected import tariff cuts and controlling for firm fixed effects in the regressions help mitigate potential endogeneity problems caused by reverse causality and omitted variables bias, in this section we further alleviate these concerns using 2SLS analysis. We use the ratio of the local supply of overconfident CEOs (i.e., the number of local overconfident CEOs) to the number of local firms as an instrument for *Overconfident CEO*. Prior studies on the directorial labor market show that the local availability

of prospective directors influences a firm's board appointment decisions (Fahlenbrach, Low, and Stulz (2010), Knyazeva, Knyazeva, and Masulis (2013)). Following similar logic, we argue that the regional pool of overconfident CEOs significantly affects a firm's CEO selection. We capture the local supply of overconfident CEOs by counting the number of distinct overconfident CEOs at ExecuComp firms headquartered within a 250-mile radius of the sample firm. We divide this number by the total number of ExecuComp firms headquartered in the same geographic area in a given year to capture an exogenous limitation on firms' ability to hire an overconfident CEO (*Local supply of overconfident CEOs*). The idea here is that, assuming firms compete to hire the limited number of overconfident CEOs in their area, hiring overconfident CEOs may not always be possible if many local firms demand such CEOs. To the extent that firms with greater access to overconfident CEOs are more likely to appoint these CEOs than firms with limited access to the pool of overconfident CEOs, we expect our instrument to be positively related to the presence of an overconfident CEO and thus satisfy the relevance requirement of an instrumental variable. Furthermore, while the numerator (i.e., the number of local overconfident CEOs) and the denominator (i.e., the number of local firms) of the instrument may be separately correlated with local factors such as the state of local economy, it is unlikely that the ratio of these two variables is directly related to firm investment and value other than through its correlation with the endogenous variable (i.e., *Overconfident CEO*) and thus we expect it to satisfy the exclusion condition of an instrumental variable. Nevertheless, to minimize the concern that our instrument may be correlated with local business conditions that affect the concentration of well-performing firms and their demand for overconfident CEOs, we control for various time-varying state-level characteristics (i.e., log (annual state population), state GDP growth, and log (state GDP)) in the

regressions. We further control for local factors and time trends by including interaction terms between region indicators and year indicators[14] as well as firm and year fixed effects.

Before presenting the 2SLS regression results, we perform OLS regressions using all non-regulated firms covered in ExecuComp from 1992 to 2015. The results are reported in Table V. In Panel A, we present results using various measures of investment as the dependent variable. In column (1), the dependent variable is the ratio of total investment to total assets (*Total investment*). We find that the coefficient on *High uncertainty* is negative and significant (at the 1% level), suggesting that firms invest less when market uncertainty is high. Importantly, consistent with the prediction of Lemma 1, we also find that the coefficient on the interaction term between *High uncertainty* and *Overconfident CEO* is positive and significant (at the 10% level), suggesting that firms led by overconfident CEOs are more likely to invest than firms led by non-overconfident CEOs when market uncertainty is high. Adding controls for CEO characteristics in column (2) does not change these results. In Panel B, we use Tobin's *q* as the dependent variable. In columns (1) and (2), we find that the coefficients on the interaction term between *High uncertainty* and *Overconfident CEO* are positive and significant, in line with the predictions of Propositions 1 and 2. In columns (3) and (4), we replace firm fixed effects with industry fixed effects and find that our results do not change. In columns (5)-(8), we divide the sample into two groups according to the sample median of *Total investment*. Although the coefficient on the interaction term between *High uncertainty* and *Overconfident CEO* is positive and significant for both groups, the magnitude of the coefficient is significantly larger for firms with high *Total investment* than for firms with low *Total investment*.

[14] Following Acharya, Baghai, and Subramanian (2014), we use the classification of the U.S. Census Bureau and divide the U.S. into four regional areas: Northeast, South, Midwest, and West.

In Table VI, Panel A we estimate 2SLS regressions of *Total investment*. Column (1) reports results of the first-stage regression in which the dependent variable is an indicator that takes the value of one for overconfident CEO firms in high uncertainty years and zero otherwise (*Overconfident CEOs during high uncertainty*) and the instrument variable is *Local supply of overconfident CEOs*. Consistent with our expectation, we find that our instrument is positively and significantly related to the endogenous variable. The *F*-statistic for the Cragg and Donald (1993) instrument relevance test is 37.03, which rejects the null hypothesis that the instrument is weak. This result confirms the relevance of our instrumental variable. Column (2) reports results of the second-stage regression in which the dependent variable is *Total investment* and the key independent variable of interest is *Overconfident CEOs during high uncertainty* from the first-stage regression. We find that the coefficient on the instrumented *Overconfident CEOs during high uncertainty* is positive and significant at the 1% level. These results suggest that our findings in the previous sections are robust to controlling for omitted variable or reverse causality bias.

In Panel B of Table VI, we estimate 2SLS regressions of Tobin's *q*. In column (1) (first-stage regression), we find a positive and significant association between the instrument and the endogenous variable. In column (2) (second-stage regression), we find that the coefficient on the instrumented *Overconfident CEOs during high uncertainty* is positive and significant at the 10% level. Subsample analyses in columns (3)-(6) further show that the significance of the coefficient on the instrumented *Overconfident CEOs during high uncertainty* in column (2) is more pronounced for firms with high *Total investment*. Thus, our finding that overconfident CEOs increase firm value more than non-overconfident CEOs during periods of high economic uncertainty appears to be robust to controlling for endogeneity concerns.

B. Alternative measures of overconfidence

In our analyses above, we use an option-based measure of CEO overconfidence with a moneyness cutoff of 67% (Malmendier and Tate (2005, 2008)). In this section we check the robustness of our results to using two alternative measures of CEO overconfidence. First, we use *Holder 100 (indicator),* an indicator that takes the value of one if the CEO postpones the exercise of vested options that are more than 100% in the money at least twice, and zero otherwise (Campbell et al. (2011)). This alternative option-based measure employs a higher cutoff in identifying overconfidence than our primary measure. Second, we use *Overconfident CEO (press),* which is the logarithm of one plus the difference between the number of "overconfident" news articles and the number of "non-overconfident" news articles (Malmendier and Tate (2008), Hirshleifer, Low, and Teoh (2012), Banerjee, Humphery-Jenner, and Nanda (2015)). An advantage of this second measure is that because it is based on past media portrayal of a CEO, it provides a validation test of our option-based measure.

In untabulated results, we find that our results for firm value (Tobin's *q*, industry-adjusted buy-and-hold returns, and CAR (-1,1)) using *Holder 100 (indicator)* and *Overconfident CEO (press)* to capture CEO overconfidence echo those using *Overconfident CEO (indicator)* as our measure of CEO overconfidence. We also find that the results for investment (ratio of total investment to total assets) using the alternative measures of CEO overconfidence are qualitatively similar to those based on *Overconfident CEO (indicator).*[15] Overall, these results suggest that our main findings are robust to using alternative measures of CEO overconfidence.

C. Overconfident CEOs and firm value: Sudden CEO deaths

[15] We do not repeat tests of Table II using the media-based measure due to its limited data availability. The media-based measure is available only in 2000, 2004, and 2006.

As a further test of the effect of managerial overconfidence on firm value, in untabulated tests, we examine whether market reactions differ between sudden deaths of overconfident CEOs and sudden deaths of non-overconfident CEOs over the 1992 to 2014 period.[16] A firm's decision to replace a CEO who dies suddenly is considered more exogenous than a firm's decision to replace a CEO due to reasons such as poor firm performance or CEO misconduct (Johnson et al. (1985)), suggesting that the loss of a CEO due to sudden death helps mitigate the concern of reverse causality in the relation between managerial overconfidence and firm value. We obtain data on sudden deaths of overconfident and non-overconfident CEOs from various sources, including Audit Analytics, BoardEx, newspaper articles, and the Corporate Library database. Following the definition of sudden death used in Nguyen and Nielsen (2010), we identify 82 deaths, of which 29 are unexpected by the market, over the period 1992 to 2014.[17] We use the VIX as our measure of economic uncertainty.[18]

We use the CAR (-1, 1) around the CEO's death date as the dependent variable. The control variables used include log (sales), leverage, cash flow / total assets, sales growth, institutional block ownership, CEO-chair duality, log (CEO tenure), and CEO age. All control variables are measured as of the fiscal year immediately prior to the CEO's death date. The regressions also include year fixed effects and industry fixed effects using the Fama and French 12-industry

[16] We do not analyze changes in investment around CEO deaths since we find that in many cases an interim CEO is appointed when a CEO has died. In these cases, it is not clear whether firm investment after a CEO's death is driven by CEO traits (i.e., overconfidence) or by an interim CEO's reluctance to change their firm's investment policy significantly.

[17] Our analysis includes both sudden and other types of deaths, as a CEO's sudden death is a rare event. Nguyen and Nielsen (2010) provide detailed definitions of sudden deaths based on the medical literature. Sudden deaths are defined as deaths that are not expected by the stock market, which excludes deaths attributed to cancer, complications from illness, past strokes, surgeries, or suicides.

[18] See www.cboe.com/micro/vix/historical.aspx.

classification.[19] As Propositions 1 and 2 predict that overconfident CEOs increase firm value more than non-overconfident CEOs during periods of high economic uncertainty, the potential loss of market value due to a CEO's death during such periods is expected to be greater for firms with an overconfident CEO than for those with a non-overconfident CEO. Consistent with this prediction, we find that the coefficient on the interaction term between *High uncertainty* and *Overconfident CEO* is negative and significant at the 10% level. In the next regression, we replace *Overconfident CEO* with *Sudden death of overconfident CEO* and *Other death of overconfident CEO*. *Sudden death of overconfident CEO* takes the value of one if the death of an overconfident CEO is unexpected and sudden, and zero otherwise; *Other death of overconfident CEO* takes the value of one if the death of an overconfident CEO is not sudden, and zero otherwise. We find the coefficient on the interaction term between *High uncertainty* and *Sudden death of overconfident CEO* is negative and significant (coefficient estimate = -8.996) while that on the interaction term between *High uncertainty* and *Other death of overconfident CEO* is insignificantly negative (coefficient estimate = -2.249). Thus, negative market reactions to the loss of an overconfident CEO during periods of high market uncertainty are driven mainly by sudden CEO deaths. Overall, these results suggest that the potential loss in market value due to a manager's sudden death during periods of high uncertainty is greater for firms with overconfident CEOs than for firms with non-overconfident CEOs, supporting our model's predictions.[20]

[19] To avoid the loss of too many degrees of freedom in estimating OLS regressions with a small sample size, we use the Fama-French 12-industry classification. Nguyen and Nielsen (2010) use the Fama-French five-industry classification to address a similar sample size problem.

[20] We acknowledge potential shortcomings of the analysis using the deaths of CEOs. Although we control for several CEO characteristics such as CEO age and tenure and CEO-chair duality in the regressions, the more negative market reaction to the death of overconfident CEOs could be due to the loss of corporate leaders with certain characteristics that we fail to control for in the regressions. Therefore, our results should be interpreted with caution.

D. Controlling for other CEO characteristics and ability

Prior studies show that CEO characteristics such as educational background (e.g., Ivy League university or MBA degree), early-life experience (e.g., Great Depression or military service experience), and decision-making power (e.g., founder or board member of another firm) affect firm value (Malmendier and Tate (2005), Malmendier, Tate, and Yan (2011), Li, Lu, and Phillips (2017)). Custodio, Ferreira, and Matos (2013) also find that CEOs with more general skills receive higher compensation and this pay premium is particularly larger for firms in industries that experience regulatory and technological shocks. Thus, it is possible that differences in managerial ability and other CEO characteristics between overconfident and non-overconfident CEOs, which allows them to identify high quality projects during periods of high market uncertainty, derive our results. To check whether overconfident and non-overconfident CEOs have different characteristics and whether these characteristics affect our results, in untabulated tests, we first conduct an univariate analysis that compares their characteristics and find that compared to non-overconfident CEOs, overconfident CEOs are more likely to be powerful (0.25% compared to 0.17%),[21] graduate from an Ivy League university (23.7% compared to 22.3%), and serve in the military (3.4% compared to 3.0%). In contrast, compared to overconfident CEOs, non-overconfident CEOs are more likely to grow up during the Great Depression (15.4% compared to 13.8%) and tend to have more general managerial skills as measured by the General Ability Index (GAI) (mean GAI of 0.089 compared to -0.03).[22] We then reestimate the regressions in Tables IV and V after controlling for these additional CEO characteristics. We find that our results do not

[21] Following Adams, Almeida, Ferreira (2005), we construct an aggregate power index that is the sum of three measures of CEO power: whether the CEO has the titles of president and chairman, whether the CEO is a founder, and whether the CEO is the board's sole insider. A CEO is classified as powerful if her power index is above the sample median.

[22] We obtain data on the GAI, which is constructed by Custodio, Ferreira, and Matos (2013) using information on a CEO's lifetime work experience, from the JFE website. Since their sample period overlaps with ours from 1993 to 2007, our tests employing this variable are conducted over a slightly smaller sample.

change, which suggests that the overconfidence measures used in our study do not simply capture other observable CEO traits. The results further support the prediction of our model: CEOs who are risk-averse but not overconfident are likely to cut overall investments during periods of high market uncertainty regardless of whether the NPV of a project is positive or negative. Although overconfident CEOs may also reduce investments during such periods, the reduction in their investments is not as drastic as that in investments made by non-overconfident CEOs, particularly for positive NPV projects.

E. Effects of CEO overconfidence on R&D investments

Among various types of investments, R&D investments tend to be particularly risky, unpredictable, long-term, and idiosyncratic. Prior studies show that R&D investments increase firm risk more than other types of investments but they contribute positively to the firm's future benefits (e.g., Kothari, Laguerre, and Leone (2002), Hall, Jaffe, and Trajtenberg (2005)). To examine whether our results in the previous section also hold when we consider only R&D investments, we first reestimate the regression in column (2) of Table V Panel A by replacing the dependent variable *Total investment* with the ratio of R&D expenditures to total assets (*R&D investment*). We find that the coefficient on the interaction term between *High uncertainty* and *Overconfident CEO* is insignificant, suggesting that *R&D investment* is similar between firms led by overconfident CEOs and those led by non-overconfident CEOs when market uncertainty is high. We then repeat the subsample analyses in Panel B of Table 5 by dividing the sample into two subgroups according to the sample median *R&D investment*. We find that although the coefficient on the interaction term between *High uncertainty* and *Overconfident CEO* is positive and significant for both subgroups, the magnitude of the coefficient is almost three times lager for firms

with high *R&D investment* than for firms with low *R&D investment*. These latter findings are largely consistent with those of our analysis using M&As (Panel B of Table IV) in that overconfident CEOs invest more in risky, value-increasing projects during periods of high economic uncertainty.[23]

VI. Conclusion

In this study, we extend previous literature on managerial overconfidence by showing that managerial overconfidence is beneficial for shareholder wealth under high economic uncertainty.

Specifically, we develop a model in which we show that managerial overconfidence moderates the underinvestment problem exacerbated by high economic uncertainty. Increasing volatilities or decreasing expected values of product prices and firm productivity during periods of high economic uncertainty exacerbate the underinvestment problems of firms managed by risk-averse managers. Managerial overconfidence offsets the underinvestment caused by risk-aversion by inducing managers to invest more in positive-NPV projects, which moves the level of firm investment closer to shareholders' first-best level and improves firm value.

We test the predictions of our model using several approaches. We first find that firms managed by overconfident CEOs invest more and perform better than those managed by non-overconfident CEOs when uncertainty is increased by industry import tariff cuts or the 2008-2009 financial crisis.

[23] The case of Corning Inc., an American multinational technology company that specializes in specialty glass and ceramics, where Roger G. Ackerman served as CEO from 1996 to 2000, illustrates how having an overconfident CEO during the crisis period adds value to the firm. Ackerman is classified as overconfident during the last two years of his term at Corning according to our definition of overconfident CEOs based on their option-holding behavior. According to the Harvard Business School Case (#703-440, November 2002), when the Asian financial crisis sent fiber prices plunging and Corning's stock prices fell in 1998, Ackerman stayed the course, even increasing R&D spending from $175 million in 1995 to $560 million in 2000 while many other CEOs pulled back their investments during the same period. The case points out that although investing heavily in R&D during the crisis period is extraordinarily risky, "historically Corning had prospered precisely because at moments like this it was willing to invest in the future..."

Subgroup analysis shows that the positive effect of overconfidence on firm value during periods of uncertainty is more pronounced for firms whose ratio of total investment to total assets is above the sample median. We also find that compared to firms with non-overconfident CEOs, those with overconfident CEOs experience more positive M&A announcement returns during periods of high stock market uncertainty and are more likely to undertake value-increasing M&As. Finally, we find that our main results are robust to using a 2SLS regression approach in which we use a local pool of overconfident CEOs as an instrument and to using alternative measures of CEO overconfidence. Overall, the results strongly support our model's predictions that managerial overconfidence reduces underinvestment problems during periods of high economic uncertainty and thus increases firm value.

Our study suggests that overconfident CEOs benefit shareholders when economic uncertainty is high and managers tend to exhibit excessive risk-aversion, resulting in underinvestment problems. While it is human nature to behave more cautiously when uncertainty rises, our study suggests that even in the absence of economic uncertainty, managerial characteristics (e.g., overconfidence) that influence managers to resist human nature may be desirable for shareholders under certain circumstances. For example, high uncertainty arising from a firm's own business operations or from firm-specific events may not deter overconfident managers from investing in value-enhancing risky projects, which can benefit shareholders. Further analysis of this question represents a valuable area for future research.

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Table I
Summary Statistics

The sample consists of 26,232 firm-year observations from 1992 to 2015 covered in ExecuComp. We start with the universe of firms covered in ExecuComp. We then exclude firms operating in regulated industries (Standard Industrial Classification (SIC) codes 4900 to 4999 and 6000 to 6999). The variable *overconfident (non-overconfident) firm* represents a firm for which the CEO postpones (does not postpone) the exercise of vested options that are more than 67% in the money at least twice. Panel A presents the distribution of sample firms according to whether a firm's CEO is overconfident. Appendix C provides detailed descriptions of the variables. ***, **, and * denote that the mean and median differences in firm and CEO characteristics between overconfident and non-overconfident firms are significant at the 1%, 5%, and 10% levels, respectively.

Panel A. Sample distribution by industry

Two-digit SIC codes	Overconfident firms: a N=13,741	Non-overconfident firms: b N = 12,491	Total (percentage of overconfident firms) N = 26,232
Agriculture, forestry, and fisheries (01-09)	9	10	19 (47.37)
Mineral industries and construction (10-17)	996	651	1,647 (60.47)
Manufacturing (20-39)	7,203	7,514	14,717 (48.94)
Transportation and communications (40-48)	901	717	1,618 (55.69)
Wholesale trade and retail trade (50-59)	1,991	1,819	3,810 (52.26)
Service industries (70-89)	2,641	1,780	4,421 (59.74)
Total	13,741	12,491	26,232 (52.38)

Panel B. Summary statistics

	Overconfident firms: a N = 13,741		Non-overconfident firms: b N = 12,491	
Variable	Mean	Median	Mean	Median
Firm characteristics				
Sales ($ billions)	4.184	1.153	4.989***	1.305***
Firm age	24.487	19.000	29.990***	24.000***
Asset tangibility	0.482	0.488	0.472***	0.482***
Leverage	0.205	0.188	0.230***	0.218***
Tobin's *q*	2.394	1.849	1.824***	1.473***
Cash flow / assets	0.097	0.104	0.069***	0.084***
CAPX / assets	0.061	0.043	0.054***	0.038***
Sales growth	1.158	1.107	1.081***	1.054***
Stock return volatility	0.118	0.102	0.115***	0.098***
Institutional block ownership	0.673	0.721	0.617***	0.670***
CEO characteristics				
CEO wealth performance sensitivity	30.851	9.855	20.265***	4.760***
CEO-chair duality (indicator)	0.627	1.000	0.517***	1.000***
CEO tenure	10.218	8.000	5.989***	4.000***
CEO age	56.255	56.000	55.304***	55.000***

Table II
Differences in Investment and Firm Value between Overconfident and Non-overconfident CEO Firms during Periods of Import Tariff Cuts: Difference-in-Differences Tests

The sample consists of 8,547 firm-year observations in manufacturing industries (Standard Industrial Classification (SIC) codes 2000-3999) from 1992 to 2005, where import tariff rates are computed using industry-level import data. Panel A presents estimates of OLS difference-in-differences regressions in which the dependent variable is the change in a firm's ratio of total investment (the sum of capital, R&D, and acquisition expenditures in a given year) to total assets from $year_{t-1}$ to $year_t$, expressed as a percentage (Δ*Total investment*). Panel B presents estimates of OLS difference-in-differences regressions in which the dependent variable is the change in Tobin's *q*. To measure unexpected reductions in import tariff rates at the four-digit SIC code level, we use U.S. import data compiled by Fresard (2015). We identify tariff reductions using the deviations in the annual change in tariff rate from the industry's median. We identify all industries in which the magnitude of the largest tariff rate reduction is three times larger than that of the median tariff rate reduction for that industry. We exclude tariff cuts that are preceded and followed by equally large increases in tariff rates to ensure that tariff reduction events reflect non-transitory changes in industry competitive environments. *Tariff cut* is an indicator that takes the value of one if an industry in which a firm operates has experienced a tariff cut over the last two years and zero otherwise. *Overconfident CEO* is an indicator that takes the value of one if the CEO postpones the exercise of vested options that are more than 67% in the money as least twice and zero otherwise. In columns (3)-(6) of Panel B, firms are divided into two subsamples, "High Δ*Total investment*" and "Low Δ*Total investment*," according to the sample median Δ*Total investment*. Appendix C provides detailed descriptions of the variables. *P*-values in parentheses are based on standard errors adjusted for heteroskedasticity and allow for clustering within firms. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Change in total investment / assets (Δ*Total investment*)

	Δ*Total investment* (%)	
Independent variable	(1)	(2)
Tariff cut (indicator)	-1.086	-1.677***
	(0.202)	(0.004)
Tariff cut (indicator) × Overconfident CEO (indicator)	2.510**	2.924***
	(0.017)	(0.001)
Log (sales)	-0.237	-0.114*
	(0.487)	(0.086)
Log (firm age)	-0.895	0.225**
	(0.277)	(0.038)
Asset tangibility	-6.432***	-4.001***
	(0.000)	(0.000)
Cash flow / assets	-12.429***	-7.445***
	(0.000)	(0.000)
Leverage	-1.152	-1.159*
	(0.384)	(0.064)
Tobin's *q*	0.079	0.077
	(0.461)	(0.197)
CEO-chair duality	0.197	0.141
	(0.555)	(0.419)
Log (CEO tenure)	-0.344**	-0.175**
	(0.025)	(0.044)
CEO age	0.000	0.001
	(0.989)	(0.923)
CEO wealth performance sensitivity	0.000	0.002*
	(0.877)	(0.098)
Year fixed effects	Y	Y
Firm fixed effects	Y	N
Industry fixed effects	N	Y
Number of observations	8,547	8,547
Adjusted R^2	0.025	0.018

Panel B. Change in firm value

	Δ Tobin's *q*			
	Full sample		Subsample	
			High Δ*Total investment*	Low Δ*Total investment*
Independent variable	(1)	(2)	(3)	(4)
Tariff cut (indicator)	0.096	0.060	-0.020	0.101
	(0.171)	(0.332)	(0.804)	(0.324)
Tariff cut (indicator) × Overconfident CEO (indicator)	0.246**	0.366***	0.446***	0.189
	(0.043)	(0.003)	(0.006)	(0.322)
Log (sales)		-0.192***	-0.229***	-0.165**
		(0.000)	(0.000)	(0.042)
Log (firm age)		0.059	-0.019	0.136
		(0.552)	(0.895)	(0.335)
Leverage		0.808***	0.890***	0.435
		(0.000)	(0.000)	(0.222)
Cash flow / assets		-0.780***	-0.450	-1.059**
		(0.000)	(0.250)	(0.010)
CAPX / assets		-2.803***	-2.810***	-3.070***
		(0.000)	(0.005)	(0.002)
Sales growth		-0.378***	-0.424***	-0.309**
		(0.000)	(0.001)	(0.022)
Stock return volatility		-2.013***	-1.876***	-2.507***
		(0.000)	(0.007)	(0.000)
Institutional ownership		-0.837***	-0.695***	-0.834***
		(0.000)	(0.001)	(0.002)
CEO-chair duality		-0.027	0.031	-0.072
		(0.531)	(0.628)	(0.335)
Log (CEO tenure)		-0.043**	-0.022	-0.062*
		(0.027)	(0.429)	(0.051)
CEO age		0.003	-0.001	0.008*
		(0.273)	(0.722)	(0.059)
CEO wealth performance sensitivity		0.002***	0.002***	0.002**
		(0.000)	(0.004)	(0.023)
Year fixed effects	Y	Y	Y	Y
Firm fixed effects	Y	Y	Y	Y
Number of observations	8,497	8,497	4,247	4,248
Adjusted R^2	0.058	0.107	0.105	0.111

Table III
Differences in Investment and Firm Value between Overconfident and Non-overconfident CEO Firms during the 2008-2009 Financial Crisis

The sample consists of 1,004 firms covered in ExecuComp as of fiscal year 2007, one year immediately before the crisis. We exclude firms in regulated industries (Standard Industrial Classification codes between 4900 and 4999 and between 6000 and 6999). We also exclude firms that experienced CEO turnovers in 2007 and 2008. Panel A presents estimates of OLS regressions in which the dependent variable is the change in a firm's ratio of total investment (the sum of capital, R&D, and acquisition expenditures in a given quarter) to total assets from the pre-crisis period (quarterly average ratio of Q1 and Q2 in 2008) to the crisis period (quarterly average ratio of Q4 in 2008 and Q1 in 2009), expressed as a percentage (Δ*Total investment*). Firm-level independent variables are measured as the changes in the values from the pre-crisis to the crisis period and CEO-level independent variables are measured as of fiscal year 2007. Panel B presents estimates of OLS regressions in which the dependent variable is a firm's industry-adjusted daily buy-and-hold returns during the financial crisis period (from August 1, 2008 to March 31, 2009). The industry-adjusted buy-and-hold return is computed as the difference between a firm's buy-and-hold return and the industry median buy-and-hold return for firms with the same two-digit SIC code. In columns (4) and (5), firms are divided into two subsamples, "High Δ*Total investment*" and "Low Δ*Total investment*," according to the sample median Δ*Total investment*. *Overconfident CEO* is an indicator that takes the value of one if the CEO postpones the exercise of vested options that are more than 67% in the money at least twice and zero otherwise. Independent variables are measured as of Q2 in 2008. Industry-adjusted pre-crisis stock returns and stock return volatility are measured using monthly data during the pre-crisis period (from December 1, 2007 to July 31, 2008). Appendix C provides detailed descriptions of the variables. *P*-values in parentheses are based on standard errors adjusted for heteroskedasticity and allow for clustering within firms. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Change in total investment / assets (Δ*Total investment*)

	Δ*Total investment* (%)	
Independent variable	(1)	(2)
Overconfident CEO (indicator)	0.653**	0.721**
	(0.032)	(0.033)
Δ Log (sales)	1.320	1.325
	(0.143)	(0.144)
Δ Log (firm age)	-0.193	-0.167
	(0.426)	(0.506)
Δ Asset tangibility	-23.545***	-23.520***
	(0.000)	(0.000)
Δ Cash flow / assets	-13.144**	-13.019**
	(0.014)	(0.015)
Δ Leverage	17.572***	17.473***
	(0.000)	(0.000)
Δ Tobin's *q*	0.072	0.084
	(0.831)	(0.800)
CEO-chair duality		0.080
		(0.803)
Log (CEO tenure)		-0.027
		(0.291)
CEO age		0.006
		(0.977)
CEO wealth performance sensitivity		-0.002
		(0.307)
Industry fixed effects	Y	Y
Number of observations	987	987
Adjusted R^2	0.188	0.186

Panel B. Industry-adjusted buy-and-hold returns

	Industry-adjusted buy-and-hold returns during the crisis				
	Full sample			Subsample	
				High Δ*Total investment*	Low Δ*Total investment*
Independent variable	(1)	(2)	(3)	(4)	(5)
Overconfident CEO (indicator)	0.052***	0.053***	0.051***	0.061**	0.036
	(0.001)	(0.001)	(0.005)	(0.019)	(0.145)

Log (sales)	-0.004	-0.005	-0.005	-0.000	-0.006
	(0.428)	(0.354)	(0.335)	(0.987)	(0.427)
Log (firm age)	-0.017	-0.016	-0.018	-0.007	-0.023
	(0.114)	(0.144)	(0.145)	(0.694)	(0.166)
Leverage	-0.141***	-0.143***	-0.159***	-0.138**	-0.198***
	(0.001)	(0.001)	(0.000)	(0.026)	(0.002)
Cash flow / assets	1.171***	1.285***	1.232***	0.956***	1.576***
	(0.000)	(0.000)	(0.000)	(0.007)	(0.000)
CAPX / assets	-0.082	-0.108	-0.135	0.703*	-0.828**
	(0.742)	(0.665)	(0.595)	(0.064)	(0.013)
Sales growth	-0.017	-0.007	0.006	-0.089	0.113
	(0.789)	(0.918)	(0.926)	(0.295)	(0.304)
Stock return volatility	-0.818***	-0.833***	-0.833***	-0.880***	-0.785***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.004)
Institutional block ownership	-0.079***	-0.079***	-0.068**	-0.080**	-0.045
	(0.004)	(0.005)	(0.018)	(0.037)	(0.297)
Industry-adjusted pre-crisis stock returns		-0.055*	-0.050	-0.062	-0.036
		(0.092)	(0.148)	(0.150)	(0.504)
CEO-chair duality (indicator)			0.007	-0.041*	0.052**
			(0.656)	(0.086)	(0.022)
Log (CEO tenure)			-0.000	-0.004	-0.001
			(0.980)	(0.787)	(0.939)
CEO age			-0.001	-0.002	0.001
			(0.646)	(0.400)	(0.765)
CEO wealth performance sensitivity			0.000*	0.000	0.000**
			(0.071)	(0.588)	(0.013)
Test (*p*-value) that the difference in coefficients for *Overconfident CEO (indicator)* between columns (4) and (5) = 0				(0.49)	
Number of observations	1,004	1,004	935	466	465
Adjusted R^2	0.089	0.091	0.095	0.075	0.140

Table IV
Overconfident CEOs and M&A Returns (Likelihood) during Periods of High Market Uncertainty

The sample consists of 3,050 successful merger and acquisitions (M&As) announced by 1,314 firms from 1993 to 2016. Panel A presents estimates of OLS regressions in which the dependent variable is the cumulative abnormal return of the acquirer from one day before to one day after the M&A announcement date, expressed as a percentage (CAR (-1, 1). Panel B presents estimates of probit regressions in which the dependent variable is an indicator that takes the value of one if the acquirer's CAR (-1, 1) is positive and zero otherwise. *High uncertainty* is an indicator that takes the value of one if *VIX* is above the sample median and zero otherwise. *VIX* is measured as the last closing price of the Chicago Board Options Exchange (CBOE) volatility index prior to the announcement date. *Overconfident CEO* is an indicator that takes the value of one if the CEO postpones the exercise of vested options that are more than 67% in the money at least twice and zero otherwise. The abnormal return is calculated using the market model. The market model parameters are estimated using 220 trading days of return data ending 60 days before the M&A announcement. The CRSP value-weighted return is used as a proxy for the market returns. Appendix C provides detailed descriptions of the variables. *P*-values in parentheses are based on standard errors adjusted for heteroskedasticity and allow clustering within firms. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Overconfident CEOs and acquirer returns (CAR (-1, 1))

	CAR (-1, 1): %	
Independent variable	(1)	(2)
High uncertainty (indicator)	-0.520	-0.694
	(0.252)	(0.203)
High uncertainty (indicator) × Overconfident CEO (indicator)	0.963**	0.913**
	(0.015)	(0.033)
Log (sales)	-0.264***	-0.339***
	(0.010)	(0.005)
Log (firm age)	-0.113	-0.191
	(0.617)	(0.455)
Leverage	1.151	0.369
	(0.218)	(0.742)
Cash flow / assets	-2.786	-2.763
	(0.241)	(0.295)
Sales growth	-0.802*	-0.763
	(0.077)	(0.104)
Stock return volatility	-2.056	-3.604
	(0.554)	(0.341)
Institutional block ownership	0.684	0.253
	(0.294)	(0.784)
Tobin's *q*	-0.123	-0.177
	(0.245)	(0.124)
Free cash flow	7.233**	7.465**
	(0.010)	(0.016)
Stock price run-up	-0.056	-0.030
	(0.891)	(0.944)
Relative deal size	0.213	-1.196**
	(0.606)	(0.017)
Diversifying acquisition (indicator)	-0.258	-0.331
	(0.347)	(0.281)
All cash (indicator)	0.781***	0.916***
	(0.003)	(0.003)
CEO-chair duality	0.077	0.317
	(0.796)	(0.355)
Log (CEO tenure)	0.005	-0.003
	(0.802)	(0.895)
CEO age	-0.057	-0.169
	(0.709)	(0.349)
CEO wealth performance sensitivity		-0.000
		(0.924)
Year fixed effects	Y	Y
Industry fixed effects	Y	Y
Number of observations	3,050	2,367
Adjusted R^2	0.060	0.050

Panel B. Likelihood of undertaking value-increasing (i.e., positive CAR (-1, 1)) M&As

	Indicator for a M&A deal having positive CAR (-1, 1)	
Independent variable	(1)	(2)
High uncertainty (indicator)	-0.088	-0.093
	(0.347)	(0.402)
High uncertainty (indicator) × Overconfident CEO (indicator)	0.190***	0.225***
	(0.010)	(0.005)
Control variables (same as in Panel A)	Y (column (1))	Y (column (2))
Year fixed effects	Y	Y
Industry fixed effects	Y	Y
Number of observations	3,041	2,356
Pseudo R^2	0.055	0.055

Table V
Differences in Investment and Firm Value between Overconfident and Non-overconfident CEO Firms during Periods of High Economic Uncertainty: Full-Sample Analysis Using OLS Regressions

The sample comprises 26,232 firm-year observations covered in ExecuComp from 1992 to 2015. We exclude firms in regulated industries (Standard Industrial Classification codes between 4900 and 4999 and between 6000 and 6999). Panel A presents estimates of OLS regressions in which the dependent variables are a firm's ratio of total investment (the sum of R&D, capital, and acquisition expenditures in a given year) to total assets, expressed as a percentage (*Total investment*). Panel B presents estimates of OLS regressions in which the dependent variable is Tobin's *q*. In columns (5)-(8), firms are divided into two subsamples, "High *Total investment*" and "Low *Total investment*," according to the sample median *Total investmen*t. *High uncertainty* is an indicator that takes the value of one if *VIX* is above the sample median and zero otherwise. *VIX* is the median value of the closing price of the Chicago Board Options Exchange (CBOE) volatility index in a given fiscal year. *Overconfident CEO* is an indicator that take the value of one if the CEO postpones the exercise of vested options that are more than 67% in the money at least twice, and zero otherwise. Appendix C provides detailed descriptions of the variables. *P*-values in parentheses are based on standard errors adjusted for heteroskedasticity and allow clustering within firms. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Investment

	Total investment (%)	
	(1)	(2)
High uncertainty (indicator)	-0.635**	-0.981**
	(0.029)	(0.027)
High uncertainty (indicator) × Overconfident CEO (indicator)	0.328*	0.466**
	(0.069)	(0.030)
Log (sales)	-0.741***	-0.321
	(0.000)	(0.159)
Log (firm age)	-1.833***	-2.438***
	(0.000)	(0.000)
Asset tangibility	-15.676***	-15.189***
	(0.000)	(0.000)
Cash flow / assets	-4.782***	-5.164***
	(0.000)	(0.000)
Leverage	4.127***	4.250***
	(0.000)	(0.000)
Tobin's *q*	0.621***	0.461***
	(0.000)	(0.000)
CEO-chair duality		0.101
		(0.647)
Log (CEO tenure)		0.117
		(0.284)
CEO age		-0.042**
		(0.010)
CEO wealth performance sensitivity		0.001
		(0.213)
Year fixed effects	Y	Y
Firm fixed effects	Y	Y
Number of observations	25,770	18,642
Adjusted R^2	0.098	0.100

Panel B. Firm value

	Tobin's *q*							
	Full sample				Subsample			
					High *Total investment*	Low *Total investment*	High *Total investment*	Low *Total investment*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
High uncertainty (indicator)	-0.284***	-0.289***	-0.302***	-0.273***	-0.452**	-0.115	-0.434**	-0.087
	(0.000)	(0.003)	(0.000)	(0.006)	(0.011)	(0.123)	(0.014)	(0.309)
High uncertainty (indicator) × Overconfident CEO (indicator)	0.309***	0.329***	0.404***	0.441***	0.436***	0.148***	0.516***	0.279***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log (sales)	-0.491***	-0.564***	-0.061***	-0.056**	-0.691***	-0.337***	-0.065*	-0.029
	(0.000)	(0.000)	(0.002)	(0.019)	(0.000)	(0.000)	(0.068)	(0.145)
Log (firm age)	-0.373***	-0.388***	-0.108***	-0.090**	-0.389*	-0.331***	-0.119**	-0.045
	(0.001)	(0.004)	(0.001)	(0.010)	(0.074)	(0.006)	(0.025)	(0.179)
Leverage	-0.433***	-0.543***	-0.565***	-0.778***	-0.518*	-0.451***	-0.804**	-0.548***
	(0.002)	(0.001)	(0.003)	(0.000)	(0.063)	(0.002)	(0.041)	(0.001)
Cash flow / assets	1.086***	0.800***	1.733***	1.375***	0.700***	1.025***	0.701	3.532***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.008)	(0.000)	(0.123)	(0.000)
CAPX / assets	0.700*	0.245	0.931	1.109	0.053	0.354	0.828	-0.099
	(0.070)	(0.547)	(0.111)	(0.109)	(0.925)	(0.696)	(0.342)	(0.916)
Sales growth	0.455***	0.448***	0.699***	0.714***	0.447***	0.375**	0.653***	0.652**
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.013)	(0.000)	(0.032)
Volatility	0.549**	0.555**	0.338	0.525	0.320	0.452*	0.439	0.690*
	(0.042)	(0.048)	(0.263)	(0.121)	(0.526)	(0.053)	(0.363)	(0.059)
Institutional block ownership	0.045	0.068	-0.121	-0.261**	0.266	-0.044	-0.351*	-0.156
	(0.667)	(0.607)	(0.172)	(0.046)	(0.247)	(0.622)	(0.089)	(0.188)
CEO-chair duality	0.030	-0.017	0.019	0.033	0.064	-0.065	0.025	0.039
	(0.437)	(0.759)	(0.623)	(0.460)	(0.458)	(0.337)	(0.725)	(0.286)
Log (CEO tenure)	-0.001	0.006	-0.016	-0.070***	-0.014	0.001	-0.083**	-0.032
	(0.957)	(0.815)	(0.442)	(0.004)	(0.719)	(0.956)	(0.021)	(0.206)
CEO age	0.001	-0.002	-0.008***	-0.005*	-0.002	0.002	-0.002	-0.007*
	(0.772)	(0.583)	(0.005)	(0.074)	(0.784)	(0.582)	(0.565)	(0.052)
CEO wealth performance sensitivity		0.000		0.002***	0.000	0.000	0.002***	0.001***
		(0.241)		(0.000)	(0.449)	(0.452)	(0.000)	(0.002)
Test (p-value) for the difference in coefficients on *High uncertainty (indicator)* × *Overconfident CEO (indicator)* between columns (7) and (8)							(0.00)	
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Firm fixed effects	Y	Y	N	N	Y	Y	N	N
Industry fixed effects	N	N	Y	Y	N	N	Y	Y
Number of observations	26,232	18,955	26,232	18,955	9,477	9,478	9,477	9,478
Adjusted R^2	0.115	0.116	0.163	0.171	0.135	0.072	0.162	0.192

Table VI
Differences in Investment and Firm Value between Overconfident and Non-overconfident CEO Firms during Periods of High Economic Uncertainty: Full-Sample Analysis Using 2SLS Regressions

The sample comprises 18,551 firm-year observations covered in ExecuComp from 1992 to 2015. We exclude firms in regulated industries (Standard Industrial Classification codes between 4900 and 4999 and between 6000 and 6999). Panels A and B presents estimates of 2SLS regressions of a firm's ratio of total investment (the sum of R&D, capital, and acquisition expenditures in a given year) to total assets (*Total investment*) and Tobin's *q*, respectively. Column (1) of both panels shows results from the first-stage OLS regression in which the dependent variable is an indicator that takes the value of one for firms managed by *Overconfident CEOs* in years with *High uncertainty* and zero otherwise (*Overconfident CEOs during high uncertainty*). *Overconfident CEO* is an indicator that take the value of one if the CEO postpones the exercise of vested options that are more than 67% in the money at least twice and zero otherwise. *High uncertainty* is an indicator that takes the value of one if *VIX* is above the sample median and zero otherwise. *VIX* is the median value of the closing price of the Chicago Board Options Exchange (CBOE) volatility index in a given fiscal year. Column (2) of Panels A and B shows results from the second-stage regressions in which the dependent variables are the firm's ratio of total investment to total assets, expressed as a percentage, and Tobin's *q*, respectively. In columns (3)-(6) of Panel B, we divide firms into two subsamples, "High total investment" and "Low total investment," according to the sample median ratio of total investment to total assets and reestimate the regressions in columns (1) and (2) separately for these two subsamples. We use the local supply of overconfident CEOs (*Local supply of overconfident CEOs*) as an instrumental variable, which is measured as the ratio of the total number of overconfident CEOs of ExecuComp firms that are headquartered within a 250-mile radius of the sample firm to the number of ExecuComp firms that are headquartered within a 250-mile radius of the sample firm in a given year. Appendix C provides detailed descriptions of the variables. *P*-values in parentheses are based on standard errors adjusted for heteroskedasticity and allow clustering within firms. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Total investment /assets

	1st stage	2nd stage
	Overconfident CEOs during high uncertainty (indicator)	*Total investment* (%)
	(1)	(2)
High uncertainty (indicator)	0.542***	-9.459***
	(0.019)	(2.607)
Instrumented:		
Overconfident CEOs during high uncertainty (indicator)		16.065***
		(4.686)
Instrumental variable:		
Local supply of overconfident CEOs	0.289***	
	(0.062)	
Log (state population)	0.013	1.349
	(0.099)	(2.346)
State GDP growth	0.000	0.044
	(0.001)	(0.038)
Log (state GDP)	0.033	-1.820
	(0.098)	(2.281)
Control variables (same as in column (2) of Panel A, Table VI)	Y	Y
Weak identification test: Cragg-Donald Wald *F*-statistic	37.03	
Year fixed effects	Y	Y
Firm fixed effects	Y	Y
Region × year fixed effects	Y	Y
Number of observations	18,234	18,234

Panel B. firm value

	Full sample		Subsample			
			High *Total investment*		Low *Total investment*	
	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage
	Overconfident CEOs during high uncertainty (indicator)	Tobin's *q*	Overconfident CEOs during high uncertainty (indicator)	Tobin's *q*	Overconfident CEOs during high uncertainty (indicator)	Tobin's *q*
Independent variable	(1)	(2)	(3)	(4)	(5)	(6)
High uncertainty (indicator)	0.546***	-0.802*	0.590***	-2.506***	0.484***	-0.960*
	(0.019)	(0.412)	(0.027)	(0.952)	(0.030)	(0.498)
Instrumented:						
Overconfident CEOs during high uncertainty (indicator)		1.297*		4.024**		1.873*
		(0.740)		(1.613)		(0.985)
Instrumental variable:						
Local supply of overconfident CEOs	0.270***		0.244***		0.244***	
	(0.062)		(0.062)		(0.072)	
Log (state population)	-0.001	0.524*	0.071	0.988	0.070	0.180
	(0.098)	(0.317)	(0.116)	(0.660)	(0.106)	(0.341)
State GDP growth	0.000	0.013***	0.002	0.037***	0.000	0.004
	(0.001)	(0.005)	(0.002)	(0.012)	(0.002)	(0.006)
Log (state GDP)	0.053	-0.518*	-0.011	-0.971	-0.023	-0.272
	(0.098)	(0.296)	(0.116)	(0.618)	(0.102)	(0.320)
Control variables (same as in column (2) of Panel B, Table VI)	Y	Y	Y	Y	Y	Y
Weak identification test: Cragg-Donald Wald *F*-statistic	32.56		14.09		13.15	
Year fixed effects	Y	Y	Y	Y	Y	Y
Firm fixed effects	Y	Y	Y	Y	Y	Y
Region × year fixed effects	Y	Y	N	N	N	N
Number of observations	18,551	18,551	9,007	9,007	9,018	9,018

Appendix A
Proofs

Proof of Lemma 1

Rewriting the manager's investment choice in *Eq.* (7), we have $I^* = f'^{-1}\left(\frac{1}{(1+A)u^{-1}E\tilde{u}\tilde{p}\tilde{z}}\right)$.

In *Eq.* (7), f'^{-1} is a decreasing function since f is strictly concave. Thus, as A increases, I^* increases. **End of proof.**

Proofs of Propositions 1 and 2

To show that A^+ increases in σ, we need to show that $E\tilde{p}\tilde{z}/(u^{-1}E\tilde{u}\tilde{p}\tilde{z})$ in *Eq.* (10) increases in σ. Because $E\tilde{p}\tilde{z}$ does not change as σ changes, the proof requires that $u^{-1}E\tilde{u}\tilde{p}\tilde{z}$ decreases in σ. $\tilde{p}\tilde{z}$ is decomposed as

$$\tilde{p}\tilde{z} = pz + \sigma\tilde{q} + \rho\tilde{r} + \tilde{q}\tilde{r}. \tag{A.1}$$

Eq. (A.1) indicates that an increase in σ generates a mean-preserving spread of the random variable $\tilde{p}\tilde{z}$ because we assume that $\text{cov}(\tilde{q},\tilde{r}) = 0$. Because $u^{-1}E\tilde{u}\tilde{p}\tilde{z}$ is the certainty equivalent of $\tilde{p}\tilde{z}$ and $u(\cdot)$ is strictly concave, $u^{-1}E\tilde{u}\tilde{p}\tilde{z}$ decreases in the mean-preserving spread of $\tilde{p}\tilde{z}$ (see Pratt (1964)).

To prove that a positive price volatility level $\bar{\sigma}$ exists such that for any price volatility level $\sigma > \bar{\sigma}$, the value of firms with overconfident managers (managers with the overconfidence level A_h) is higher than that of firms with non-overconfident managers (managers with the overconfidence level A_l), we first need to show that both the investment level A_l and the investment level A_h decrease in σ. From *Eq.* (7), we have $I^* = f'^{-1}\left(\frac{1}{(1+A)u^{-1}E\tilde{u}\tilde{p}\tilde{z}}\right)$ and thus the proof requires that $u^{-1}E\tilde{u}\tilde{p}\tilde{z}$ decreases in σ, which is shown above. According to Lemma 1, for any level of price volatitiliy σ, the investment level of firms with overconfident managers is higher than that of firms with non-overconfident managers. Thus, $\bar{\sigma}$ can be determined at the level where the value of firms with overconfident managers is the same as that of firms with non-overconfident

managers since firm value is concave in the investment level. Let us define firm value as a function of A and σ, which is denoted by V(A, σ). Then, V(A_h, σ) is increasing in σ and V(A_l, σ) is decreasing in σ when firms with overconfident (non-overconfident) managers have overinvestment (underinvestment) problems. Thus, a positive price volatility level $\bar{\sigma}$ exists for which V(A_h, $\bar{\sigma}$) = V(A_l, $\bar{\sigma}$). We can prove Proposition 2 in the same way since an increase in ρ generates a mean-preserving spread of the random variable $\widetilde{p}\widetilde{z}$. **End of proofs.**

Proofs of Propositions 3 and 4.

We define $k = u^{-1}Eu(\widetilde{pz})$. We then have

$$Eu(\widetilde{pz}) = u(k). \tag{A.2}$$

Differentiating *Eq*. (A.2) with respect to p, we have

$$zEu'(\widetilde{pz}) = u'(k)\frac{dk}{dp}. \tag{A.3}$$

From *Eqs*. (A.2) and (A.3), we have

$$zEu'(\widetilde{pz}) = u'\left(u^{-1}Eu(\widetilde{pz})\right)\frac{dk}{dp}. \tag{A.4}$$

We then need to show that $E[\widetilde{pz}]/k$ is decreasing in p. Differentiating $E[\widetilde{pz}]/k$ with respect to p, we have

$$\frac{zk - pz\frac{dk}{dp}}{k^2}. \tag{A.5}$$

From *Eq*. (A.5), we can derive the condition that $E[\widetilde{pz}]/k$ is decreasing in p:

$$k - p\frac{dk}{dp} < 0,$$

which is equivalent to

$$\frac{dk}{dp} > \frac{k}{p}. \tag{A.6}$$

Because k is the certainty equivalent of $\widetilde{pz}$ and the utility function is strictly concave, we have $k < E[\widetilde{pz}] = pz$. Therefore, the sufficient condition for the inequality in *Eq.* (A.6) to be satisfied is $\frac{dk}{dp} > z$.

From *Eq.* (A.4), the condition that $\frac{dk}{dp} > z$ is that

$$\frac{zEu'(\widetilde{pz})}{u'\left(u^{-1}Eu(\widetilde{pz})\right)} > z,$$

which is equivalent to

$$Eu'(\widetilde{pz}) > u'\left(u^{-1}Eu(\widetilde{pz})\right). \tag{A.7}$$

Because u' is a decreasing function, inequality in *Eq.* (A.7) is equivalent to

$$(u')^{-1}\, Eu'(\widetilde{pz}) < u^{-1}Eu(\widetilde{pz}). \tag{A.8}$$

According to Pratt (1964), the inequality of *Eq.* (A.8) implies that the utility function u' has higher absolute risk-aversion than the utility function u. Therefore, *Eq.* (A.8) is equivalent to

$$-\frac{u'''}{u''} > -\frac{u''}{u'}. \tag{A.9}$$

The decreasing absolute risk-aversion (DARA) utility function implies that

$$\frac{\partial(-\frac{u''(x)}{u'(x)})}{\partial x} < 0,$$

which is equivalent to

$$\frac{-u'''u' + (u'')^2}{(u')^2} < 0. \tag{A.10}$$

Because we know that the inequalities in *Eqs.* (A.9) and (A.10) are equivalent, we have $\frac{dk}{dp} > z$. We can prove the case for a change in z (Proposition 4) in a same way. **End of proofs.**

Appendix B
Model Extension: Effects of Declines in the Expected Values of Product Prices and Firm Productivity on the Optimal Level of Managerial Overconfidence

Economic uncertainty not only increases the volatility of product price and firm productivity but also lowers their expected values. For example, more intensive industry competition triggered by a reduction in import tariffs can lead to a large reduction in the expected price of the products (Kreinin (1961)). Similarly, during the 2008-2009 financial crisis, when investor sentiment, employment, and consumer demand were negatively affected by the economic shock, the expected value of firm productivity also plunged significantly.[24]

To examine how a decline in the expected values of product prices and firm productivity affect the optimal level of managerial overconfidence during periods of high economic uncertainty, we further assume that the manager's absolute risk-aversion is decreasing in the expected value of her reward. That is,

$$\frac{\partial\left(-u''(x)/u'(x)\right)}{\partial x} < 0\,, \tag{B.1}$$

where x is the expected value of the manager's reward, and u' and u'' are the first- and second-derivatives of her utility function, respectively. Following Pratt ((1964)) and Arrow ((1965)), we assume that a manager's absolute risk aversion is a decreasing function of her wealth (i.e., decreasing absolute risk-aversion (DARA) utility function), which captures an individual's general tendency to behave in a less risk-averse fashion as her wealth increases.[25] Thus, under the DARA utility function, a reduction in the expected product price causes the manager to become more risk averse, aggravating the underinvestment problems. These underinvestment problems can be mitigated if the manager is overconfident because she overestimates the returns from her investment and thus invests more than a non-overconfident manager.

[24] For example, during the 2008-2009 financial crisis, U.S. total factor productivity (TFP), which measures the effectiveness of the utilization of labor and capital inputs in production processes, declined by 0.25% according to data compiled by the Organization for Economic Cooperation and Development (OECD) from 1985 to 2015. The negative TFP growth rate of the U.S. during the 2008-2009 crisis represents a record low followed by that (−0.1%) reported in 1995.

[25] Supporting the view that people follow the DARA utility function, Hamal and Anderson (1982) show that Nepalese farmers become less risk averse as they become wealthier. The assumption of the DARA utility function is routinely used in theoretical works on the economics of uncertainty (Sandmo (1971), Batra (1975), Friend and Blume (1975), Kimball (1990)).

The following proposition summarizes the effect of a decrease in a product's expected price on the optimal level of managerial overconfidence.

Proposition 3 *As the expected market price of a product (i.e., p) decreases, the optimal level of managerial overconfidence increases.*
Proof. See Appendix A.

Similarly, a decrease in the expected value of firm productivity during periods of high economic uncertainty causes a manager to become more risk averse under the DARA utility function since the reduced value of firm productivity translates into a drop in the expected value of the manager's reward. Thus, a decrease in the expected value of firm productivity worsens underinvestment problems. Managerial overconfidence offsets the negative effects of managerial risk-aversion on investments by increasing the level of firm investment closer to its optimal level. The following proposition summarizes this discussion.

Proposition 4 *As the expected value of firm productivity (i.e., z) drops, the optimal level of managerial overconfidence increases.*
Proof. See Appendix A.

Appendix C

This appendix provides detailed descriptions of all the variables used in the tables.

Variables	Description	Source
Firm characteristics		
Asset tangibility	(0.715 × total receivables + 0.547 × inventories + 0.535 × net property plant and equipment + cash and short-term investments) / total assets (Almeida et al. (2014))	Compustat
CAPX / assets	Capital expenditures / total assets	Compustat
Cash flow / assets	(Net income + depreciation and amortization) / total assets	Compustat
Free cash flow	(Operating income before depreciation – interest expenses – income taxes – capital expenditures) / total assets	Compustat
Industry-adjusted pre-crisis stock returns	Firm's daily buy-and-hold returns during the pre-crisis period (from December 1, 2007 to July 31, 2008) –median return for a firm's two-digit SIC code during the same period	Compustat, CRSP
Institutional block ownership	Number of shares held by institutional shareholders that own more than 5% of a firm's equity / total number of shares outstanding	Thompson13F
Leverage	(Long-term debt + debt in current liabilities) / total assets	Compustat
Log (firm age)	Logarithm of max (years in CRSP, years in Compustat)	Compustat, CRSP
Log (sales)	Logarithm of sales in millions of 2005 dollars	Compustat
Sales growth	$Sales_t$ / $Sales_{t-1}$	Compustat
Stock return volatility	Standard deviation of a firm's monthly stock returns during a fiscal year	CRSP
Tobin's q	(Total assets – book equity + market value of equity) / total assets	Compustat
Total investment	Sum of capital, R&D, and acquisition expenditures in a given year. Missing values for R&D expenditures are coded with a zero.	Compustat
CEO characteristics		
CEO age	CEO age in years	ExecuComp, Proxy statements
CEO wealth performance sensitivity	Dollar change in CEO wealth for a one-percentage-point change in firm value, scaled by the CEO's annual pay	Alex Edman's website
CEO-chair duality (indicator)	One if the CEO is also the chair of the board and zero otherwise	ExecuComp
Holder 100 (indicator)	One if the CEO postpones the exercise of vested options that are more than 100% in the money at least twice and zero otherwise	ExecuComp
Log (CEO tenure)	Logarithm of the number of years the CEO has served as CEO	ExecuComp, BoardEx
Overconfident CEO (indicator)	One if the CEO postpones the exercise of vested options that are more than 67% in the money at least twice and zero otherwise	ExecuComp
Overconfident CEO (press):	Logarithm of one plus net news, which is the difference between the number of news articles that use "confident" termsand the number of news articles that use "cautious" terms	(Banerjee, Humphery-Jenner, and Nanda (2015)
M&A deal characteristics		
All cash (indicator)	One for purely cash-financed deals and zero otherwise	SDC
Diversifying acquisition (indicator)	One if a bidder and a target do not share the same SIC two-digit code and zero otherwise	SDC
Relative deal size	Deal value divided by a bidder's market value of equity (number of shares outstanding multiplied by the stock price on the 11th trading day prior to the announcement date)	CRSP
Stock price run-up	Bidder's buy-and-hold abnormal return during the period (−210, −11), where day 0 is the M&A announcement date. The CRSP value-weighted return is used as the market index return	CRSP
State economic characteristics		

Log (state GDP)	Logarithm of state GDP (millions of current dollars)	U.S. Bureau of Economic Analysis
Log (state population)	Logarithm of state annual population in a given year	U.S. Bureau of Economic Analysis
State GDP growth	Percent change in state GDP in a given year from the preceding period	U.S. Bureau of Economic Analysis
Economic uncertainty characteristics		
Tariff cut (indicator)	One if an industry in which a firm operates has experienced a tariff cut over the last two years and zero otherwise. We first identify tariff reductions using the deviation in the annual change in tariff rate from the industry's median. We then identify all industries in which the largest tariff rate reduction is three times larger than the median tariff rate reduction in that industry. We exclude tariff cuts that are preceded and followed by equally large increases in tariff rates to ensure that the tariff cut events reflect non-transitory changes in an industry competitive environments	Fresard (2015)
High uncertainty (indicator)	One if the last closing price of the VIX (Chicago Board Options Exchange (CBOE) volatility index) prior to the start of the period under analysis is above the sample median and zero otherwise	Chicago Board Options Exchange (CBOE) website