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CEO overconfidence and the value of corporate cash holdings

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A B S T R A C T

Cash holding is on average more valuable when firms are managed by overconfident CEOs. Economically, having an overconfident CEO on board is associated with an increase of \$0.28 in the value of \$1.00 cash holding. The positive effect of CEO overconfidence on the value of cash concentrates among firms that are more likely to suffer from the underinvestment problem (i.e., financially constrained firms which exhibit high growth opportunities). In addition, CEO overconfidence affects negatively the value of cash in firms that are financially unconstrained, a finding which is consistent with the overinvestment hypothesis. The results are robust to various tests and alternative explanations.

1. Introduction

Starting from the pioneering works of Faulkender and Wang (2006) and Pinkowitz et al. (2006), numerous studies have analyzed the value of cash holdings (i.e., the value the market assigns to an additional dollar of cash holding).¹ The traditional views are that the value of cash depends: (i) on the information asymmetry between managers and the capital markets (Myers and Majluf (1984)); and (ii) on agency problems that arise due to misalignment of managerial and shareholders' interests (Jensen and Meckling (1976)).² These studies assume that CEOs are rational. However, a growing body in the corporate finance literature finds that CEO characteristics and behavioral biases affect corporate policies and decisions (see, for instance, Bertrand and Schoar (2003), Malmendier and Tate (2005), (2008), Hirshleifer et al. (2012) and Huang and Kisgen (2013)). Motivated by this literature, this study investigates how CEO overconfidence, one of the most prominent behavioral biases, affects the value of cash.

To develop our empirical predictions, we build our theoretical reasoning based on the model derived in Malmendier and Tate (2005). The model assumes an efficient capital market where there are two types of CEOs in the economy: rational CEOs and overconfident CEOs. Both CEO types maximize shareholder value. The only friction in the model comes from the overconfident CEO's perception about the firm's future cash flows; that is, overconfident CEOs overestimate the firm's future cash flows. This implies that: (i) overconfident CEOs perceive their firm as being undervalued by the market (Malmendier and Tate (2005)); and (ii) overconfident CEOs misperceive the cost of capital required by rational creditors and equity investors for providing external financing to the firm (Malmendier et al. (2011)). More specifically, overconfident CEOs avoid external financing, as it is perceived to be relatively more

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E-mail address: d.petmezas@surrey.ac.uk (D. Petmezas).¹ See, e.g., Pinkowitz et al. (2006), Dittmar and Mahrt-Smith (2007), Kalcheva and Lins (2007), Denis and Sibilkov (2010), Frésard and Salva (2010), Liu and Mauer (2011), Harford et al. (2014), and Chen et al. (2017).² Under information asymmetry, capital market frictions increase the cost of external finance relative to internal finance, inducing cash-poor firms with high growth opportunities to underinvest. Cash holding is therefore valuable for these firms as it allows them to further deplete their investment opportunities (see, e.g., Faulkender and Wang (2006) and Denis and Sibilkov (2010)). Under the agency theory, powerful managers may waste cash by reaping private benefits. Consequently, cash holding has a lower value in firms affected by agency problems (see, e.g., Faulkender and Wang (2006), Pinkowitz et al. (2006) and Dittmar and Mahrt-Smith (2007)).<https://doi.org/10.1016/j.jcorpfin.2018.11.006>

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costly, and rely more on internal funds to finance their investment opportunities.³

An important implication of this theoretical framework is that the impact of CEO overconfidence on firm investment and the marginal value of cash will depend on the availability of internal financing (i.e., cash reserves and operating cash flows). Specifically:

- If internal financing is more than sufficient to fund all positive NPV projects, overconfident CEOs exhibit an excessive willingness to invest relative to rational CEOs. Consistent with this notion, [Malmendier and Tate \(2005, 2008\)](#) document that CEO overconfidence in cash rich firm is associated with capital expenditure distortions and excessive mergers and acquisitions activity, which leads to negative market reactions upon announcements. Under this *overinvestment hypothesis*, CEO overconfidence may affect negatively the value of cash, because additional cash holdings might further exacerbate overinvestment by the funding of value destroying projects;
- If internal financing is insufficient to fund all positive NPV projects, however, overconfident CEOs may underinvest relative to rational CEOs; this is the case when overconfident CEOs perceive external financing cost to be higher than the perceived investment return.⁴ Along these lines, [Malmendier and Tate \(2005, 2015\)](#) show that CEO overconfidence amplifies the sensitivity of corporate investment to internally generated cash, suggesting that the average firm with an overconfident CEO behaves as if it is financially constrained.⁵ Therefore, under this *costly external finance hypothesis*, the value of cash should be positively associated with CEO overconfidence, as additional cash holding may allow the firm to alleviate potential underinvestment problem.

In general, both the overinvestment and costly external finance hypotheses may coexist and affect the value of cash. This is particularly important because each hypothesis has different policy implications and extant overconfidence literature puts largely the emphasis on the overinvestment hypothesis (see, e.g., [Roll \(1986\)](#) and [Malmendier and Tate \(2005, \(2008\)\)](#)).⁶ Furthermore, if both hypotheses coexist empirically, then which of these two hypotheses dominates for the average firm with an overconfident CEO is an open empirical question.

To investigate these questions, we rely on one obvious dimension where the empirical predictions of overinvestment and costly external finance hypotheses differ; that is the value that the market assigns to firm's cash holding. [Halford et al. \(2017\)](#) emphasize that the marginal value of cash holdings offers an appealing tool to investigate the value consequences of various firm outcomes and environments. In addition, as pointed out by [Halford et al. \(2017\)](#), the reasons are that cash is comparable across firms, and it can be quickly deployed either to exacerbate overinvestment by the funding of value-destructive projects or to alleviate underinvestment by the exploitation of valuable growth opportunities. Finally, cash is relatively more homogeneous in comparison to corporate investment (i.e., capital expenditures, R&D, mergers and acquisitions), which may differ substantially in terms of risk and liquidity characteristics across firms. Therefore, the value of cash framework is well suited to examine the overinvestment/underinvestment hypotheses.

We test our empirical questions using a measure of overconfidence based on revealed beliefs as captured by CEO's option exercising behavior (see, e.g., [Malmendier and Tate \(2008\)](#) and [Malmendier et al. \(2011\)](#)) and the valuation approach of [Faulkender and Wang \(2006\)](#). This approach uses excess equity returns to estimate the marginal value of additional cash. Controlling for other known determinants of the value of cash, the results show a strong positive relation between CEO overconfidence and the marginal value of an additional dollar of cash. This relation is driven by firms with high - than low - degree of CEO confidence. In economic terms, having an overconfident CEO on board increases the value of \$1.00 cash holding by an additional amount of \$0.28 relative to a firm run by a rational CEO. These results are robust to controlling for firm fixed effects that remove the impact of time-invariant firm characteristics. Furthermore, a propensity score matching assures that the CEO overconfidence effect is not explained by observable differences (such as firm or CEO characteristics) between firms managed by overconfident versus rational CEOs. In addition, we find similar results using two alternative proxies of overconfidence based on business press portrayal of the CEO and CEOs/CFOs gender (i.e., male). Finally, we control for cash regimes following the approach advocated by [Halford et al. \(2017\)](#); as expected under the costly external finance hypothesis, we find that the positive effect of CEO overconfidence on the marginal value of cash is particularly strong in firms that are in the raising cash regime (i.e., these are firms that require external finance to fund valuable projects).

We consider a variety of alternative explanations. First, CEO heterogeneous characteristics may be related to late option exercising behavior. Thus, the option-based measure of CEO overconfidence may be positively associated with the value of cash, through other mechanisms, besides overconfidence. Such characteristics include CEO ability and risk tolerance aptitudes. More able managers may expect strong future performance, thus refraining from option exercising even if they are deep in the money. Similarly,

³ [Heaton \(2002\)](#) suggests that overconfident managers prefer internal financing to external funds for investment projects and [Malmendier et al. \(2011\)](#) find that overconfident managers are less likely to use external finance and issue less equity. However, recently, [Banerjee et al. \(2015\)](#) provide evidence that overconfident CEOs are also more likely to conduct SEOs in order to increase investment (in CAPEX and R&D), stockpile cash, and continue acquisition activity.

⁴ Under this scenario, overconfident CEOs with insufficient internal financing may tap external finance and overinvest if and only if the perceived investment return is higher than the perceived financing cost ([Malmendier et al. \(2011\)](#)).

⁵ [Malmendier and Tate \(2005\)](#) also argue that additional cash flow provides an opportunity for overconfident CEOs to invest closer to their desired level.

⁶ In fact, [Malmendier and Tate \(2015\)](#) on page 39 are cautious about the implications that arise from CEO overconfidence by stating: "...In considering how CEO overconfidence might affect decision-making, it is important to model an explicit decision-making framework that offers predictions about how rational CEOs will differ from overconfident CEOs. As an example of the pitfalls that can arise with a model-free approach, we point to the common intuition equating hubris with corporate overinvestment."

more risk tolerant CEOs may also be reluctant to exercise their options. At the same time, they are expected to implement riskier firm policies and accumulate optimally higher cash reserves (Acharya et al. (2012)). Controlling for managerial ability and risk tolerance, however, does not affect the results. Second, an endogenous matching between CEO and firm characteristics could create spurious results when latent firm characteristics that correlate with the value of cash induce firms to appoint overconfident CEOs. We therefore re-run the main analysis and find qualitatively similar results after excluding from the sample observations for which CEO tenure is less than one year, less than three years, and less than five years, which likely relate more to the appointment decision, and thus could potentially cause a spurious relationship.

Overall, the results support the view that CEO overconfidence affects positively the value of cash and that the costly external finance hypothesis dominates the overinvestment hypothesis for the average firm with an overconfident CEO. To further examine the validity of both hypotheses, we use subsamples of firms that exhibit different degrees of financial constraints. Overinvestment is more likely when the firm has abundant resources (i.e., financially unconstrained), while underinvestment is more likely when the firm has limited resources (i.e., financially constrained). The results show that among financially unconstrained firms CEO overconfidence affects negatively the value of cash, providing support to the overinvestment hypothesis. In contrast, among financially constrained firms, the results show a positive relation between CEO overconfidence and the value of cash, consistent with the costly external finance hypothesis.

Finally, we also examine which firms are more likely to be affected by the costly external finance hypothesis. Galasso and Simcoe (2011) and Hirshleifer et al. (2012) find that overconfident CEOs are more likely to pursue innovation and exploit growth opportunities. Therefore, underinvestment problems should be more pronounced among financially constrained firms that exhibit high innovative growth opportunities. We test this perspective using industry R&D expenditures as a proxy for the existence of innovative growth opportunities. Industry expenditures are largely exogenous to firm growth opportunities, and thus, help to alleviate potential endogeneity concerns about the relation between the level of firms' cash holdings and the availability of growth opportunities. The results, as expected, show that the positive effect of CEO overconfidence on the value of cash concentrates among financially constrained firms with high growth opportunities. These results imply that additional cash benefits financially constrained firms with overconfident CEOs in the presence of high growth opportunities. Therefore, consistent with theoretical models that discuss benefits to overconfidence, such as those of Goel and Thakor (2008) and Gervais et al. (2011), underinvestment is more value destroying for shareholders when opportunities to benefit from overconfidence are present.

Our study offers important contributions to prior literature. We contribute to the cash holding literature by showing that CEO overconfidence, an important managerial trait, affects on average the value of cash holdings. Prior literature emphasizes the role of a firm's financial constraint status (see, e.g., Faulkender and Wang 2006), growth opportunities (see, e.g., Denis and Sibilkov (2010)), corporate governance (see, e.g., Pinkowitz et al. (2006), Dittmar and Mahrt-Smith (2007) and Kalcheva and Lins (2007)), and CEO risk-taking incentives (Liu and Mauer (2011)). Controlling for these well-known determinants of the value of cash, this study adds to the literature by documenting that CEO overconfidence affects positively the value of cash on average, and particularly in the presence of financial constraints and high growth opportunities.

The study also contributes to the managerial overconfidence literature. Existing literature has primarily focused on investment (Malmendier and Tate (2005), (2008)), innovation (Hirshleifer et al. (2012)), earnings management forecasts (Hribar and Yang (2015)), financing (Malmendier et al. (2011)), payout policies (Deshmukh et al. (2013)), and stakeholder commitments (Phua et al. (2018)). Less is known, however, about the effect of managerial overconfidence on firm's cash policy. Deshmukh et al. (2016) examine the effect of managerial overconfidence on the level of cash holdings. We complement this study by showing that additional cash is valuable for overconfident CEOs, as it allows the firm to further exhaust its investment opportunities.

Finally, we contribute indirectly to the impact of managerial overconfidence on (over/under)investment. Particularly, Malmendier and Tate (2005), (2015) show that CEO overconfidence amplifies the sensitivity of corporate investment to internally generated cash. While it is hardly questionable that financial slack affects investments by overconfident CEOs, it is less clear whether this leads their firms to systematically overinvest or underinvest. One obvious dimension along which the empirical predictions of the (over/under)investment differ is the value that the market assigns to additional cash. Thus, our findings are useful to understand how CEO overconfidence affects firm value. A strand of the literature demonstrates that overconfident managers implement value destroying corporate investments (see, e.g., Roll (1986) and Malmendier and Tate (2008)), emphasizing the effect of managerial overconfidence on overinvestment for financially unconstrained firms. We corroborate these results as we find a negative effect of CEO overconfidence on the value of cash for firms that are financially unconstrained. However, in an important departure from prior literature, this study highlights also the importance of the underinvestment problem for the average firm with an overconfident CEO. Specifically, we show that additional cash holdings allow overconfident CEOs to alleviate underinvestment problem increasing their firm's value. This relation concentrates among firms that are financially constrained and exhibit high growth opportunities. Therefore, this finding is consistent with another strand of the literature that shows that managerial overconfidence may create value in certain settings, for instance, by pursuing good but risky projects (Campbell et al. (2011), Goel and Thakor (2008), Galasso and Simcoe (2011) and Gervais et al. (2011)), and by encouraging entrepreneurship and innovation (Bernardo and Welch (2001) and Hirshleifer et al. (2012)).

The remainder of the paper proceeds as follows. Section 2 describes the sample, the measure of CEO overconfidence, and the variables used in the empirical analysis. Section 3 examines the impact of CEO overconfidence on the value of an additional dollar of cash holdings and considers several robustness checks and potential alternative explanations. Section 4 investigates whether CEO overconfidence affects the value of cash through the underinvestment or overinvestment channel by utilizing the firm's financial constraint status (and growth opportunities). Section 5 concludes the paper.

2. Data, sample selection and variable definitions

2.1. Data sources and sample selection

To construct the sample, we use the Center for Research in Security Prices (CRSP) to obtain stock returns, and Standard and Poor's Compustat Industrial Annual (CIA) and ExecuComp databases to obtain accounting- and CEO- related information. The initial sample consists of the intersection of firms that are included in the above-mentioned databases. We exclude firms in the financial and utility sectors (SIC codes between 6000 and 6999 and 4900–4999, respectively). Further, consistent with [Faulkender and Wang \(2006\)](#), we eliminate firm-year observations with negative sales, negative net assets, negative dividends and negative capital expenditures. Finally, we exclude firm-year observations with market value of equity < 25 million in constant 2013 dollars. The final sample consists of 12,105 firm-year observations and covers the period 1993–2013.

2.2. Measure of CEO overconfidence

Similar to [Malmendier and Tate \(2005\)](#), we measure managerial overconfidence using a CEO stock options proxy, which we label as *overconfident CEO*. In particular, the measure of overconfidence is based on CEOs' revealed beliefs captured by their preference not to exercise stock options timely, as would typically be optimal for risk-averse undiversified executives, though they are deep in the money ([Hall and Murphy \(2002\)](#)). We exploit information about all outstanding options held by a CEO that are directly observable starting in 2006 due to requirements from the FAS 123R and we identify CEOs who, at least once during the period 2006–2013, hold an option until the year of expiration, even though the stock option is at least 40% in-the-money entering its final year. For the median firm, the percentage of in-the-money options held to expiration entering the final year in our sample is 99.47%. Therefore, given that a typical option has a 10-year duration and is fully vested by the fifth year, longholder captures habitual, rather than time-varying, failure of CEOs to diversify across several years. Accordingly, we back filled the classifications of each CEO during her entire tenure for the period 1993–2013; that is, we apply this measure as a CEO fixed effect. Finally, CEOs that never exercise options do not reveal beliefs and, thus, we exclude them from the sample.⁷

We further group overconfident CEOs into low versus high degree of confidence. Specifically, the measure of overconfidence is based on CEOs' preference not to exercise stock options timely, though they are at least 40% in the money. The threshold of 40% is based on the model of [Hall and Murphy \(2002\)](#) assuming a constant relative risk aversion of three and 67% of wealth in firm stock. Thus, by changing this threshold, we may extract information about different degrees of CEO confidence. We define CEOs that hold an option until the year of expiration, and the option entering its final year is less (greater) than 66.22% in the money, to exhibit low (high) degree of confidence. The threshold of 66.22% is the 25th percentile in-the-money option value of the sample.

2.3. Summary statistics

[Table 1](#) provides information about the frequency of overconfident CEOs in our sample. On average, the option-based overconfidence measure identifies a proportion of 27.72% of overconfident CEOs-years, which is slightly greater than the 22.18% reported by [Malmendier et al. \(2011\)](#). Our measure identifies relatively more overconfident CEO-year observations because a CEO who is identified as overconfident in any year, retains this classification during her entire tenure. This, in addition, implies that the proportion of overconfident CEOs should increase across time. This pattern is evident in the early rather than the late years of the sample period; that is perhaps due to increased CEO turnovers during the later years of the sample period (see, e.g., [Kaplan and Minton \(2011\)](#)) or forced turnovers of excessively optimistic CEOs ([Campbell et al. \(2011\)](#)). The average proportion of high-confident CEOs is 20.81% in our sample.

[Table 2](#) provides descriptive statistics about firm and CEO characteristics. Overconfident CEOs manage smaller firms. For instance, the median assets and sales of firms with overconfident CEOs are significantly lower than the assets and sales of firms with rational CEOs. In our sample, firms with overconfident CEOs exhibit lower sales growth and Tobin's Q, larger cash reserves, greater debt to total assets (leverage), and lower profitability as measured by return on assets than firms with rational CEOs. Interestingly, these firms also spend more on research and development (R&D) to net assets. The latter statistic, consistent with [Galaso and Simcoe \(2011\)](#) and [Hirshleifer et al. \(2012\)](#), shows that overconfident CEOs invest more in innovation. Regarding CEO characteristics, there is no significant difference in the age and risk-taking incentives (i.e., vega) between overconfident and rational CEOs, while overconfident CEOs receive lower incentive compensation associated to stock performance (i.e., delta).

⁷ The exclusion of CEOs that never exercise options from the final sample might raise a sample selection bias problem. Thus, to investigate whether such bias affects our results, we keep those CEOs in the sample and classify them as rational. Then, we re-run the main analysis. Since some of these (unclassified) CEOs might be overconfident, this approach is conservative and is biasing against finding significant differences in the value of cash between overconfident and rational CEOs. Despite that, untabulated results show that our main findings remain qualitatively similar.

Table 1
Sample Distribution by Year.

Year	Total	Overconfident		High-confident		Rational	
		Number	Proportion (%)	Number	Proportion (%)	Number	Proportion (%)
1993	66	19	28.79	15	22.73	47	71.21
1994	121	33	27.27	23	19.01	88	72.73
1995	139	36	25.90	27	19.42	103	74.10
1996	163	42	25.77	32	19.63	121	74.23
1997	187	49	26.20	38	20.32	138	73.80
1998	243	70	28.81	52	21.40	173	71.19
1999	282	87	30.85	65	23.05	195	69.15
2000	363	113	31.13	87	23.97	250	68.87
2001	422	116	27.49	91	21.56	306	72.51
2002	489	135	27.61	101	20.65	354	72.39
2003	588	165	28.06	122	20.75	423	71.94
2004	682	192	28.15	141	20.67	490	71.85
2005	779	232	29.78	173	22.21	547	70.22
2006	851	244	28.67	185	21.74	607	71.33
2007	1038	294	28.32	221	21.29	744	71.68
2008	1020	280	27.45	210	20.59	740	72.55
2009	953	260	27.28	197	20.67	693	72.72
2010	984	266	27.03	199	20.22	718	72.97
2011	979	271	27.68	204	20.84	708	72.32
2012	912	241	26.43	181	19.85	671	73.57
2013	844	211	25.00	155	18.36	633	75.00
Total	12,105	3356	27.72	2519	20.81	8749	72.28

This table displays the yearly breakdown of the number and the proportion of overconfident and rational CEO firm-year observations. The sample consists of 12,105 firm-year observations that cover the period 1993–2013. To be included in the sample, firms are required to belong in the S&P 1500 index with available observations in the ExecuComp, CRSP, and Compustat databases. In addition, we exclude firm-years with market value of equity < 25 million in constant 2013 dollars, negative sales, negative net assets, negative dividends, negative capital expenditures and firms from the financial (SIC 6000-6999) and utility (SIC 4900-4999) industries. CEO overconfidence is based on a longholder measure. Longholder measure definition is in Appendix A.

Table 2
Summary Statistics.

	All sample		Overconfident		Rational	
	Mean	Median	Mean	Median	Mean	Median
Firm characteristics						
Total assets (\$)	7726.10	1671.14	9815.29***	1397.97***	6924.72	1765.28
Sales (\$)	6943.10	1634.85	6259.62**	1362.27***	7205.28	1763.94
% ΔSales	0.063	0.057	0.038***	0.034***	0.072	0.064
Q	2.038	1.625	1.879***	1.433***	2.099	1.705
Cash	0.165	0.100	0.196***	0.137***	0.153	0.089
Leverage	0.178	0.133	0.210***	0.149***	0.166	0.128
Profitability	0.148	0.141	0.117***	0.115***	0.159	0.151
Capital expenditures	0.066	0.045	0.060***	0.041***	0.069	0.047
Cash acquisitions	0.037	0.002	0.031***	0.000***	0.039	0.002
R&D expenses	0.063	0.003	0.091***	0.007***	0.053	0.001
CEO Characteristics						
CEO age	54.928	55.000	54.924	55.000	54.930	55.000
Vega/TC	0.028	0.019	0.029	0.019	0.028	0.019
Delta/TC	0.211	0.067	0.193**	0.054***	0.217	0.072

This table displays summary statistics on firm and CEO characteristics for firms managed by overconfident and rational CEOs. The sample consists of 12,105 firm-year observations that cover the period 1993–2013. To be included in the sample, firms are required to belong in the S&P 1500 index with available observations in the ExecuComp, CRSP, and Compustat databases. In addition, we exclude firm-years with market value of equity < 25 million in constant 2013 dollars, negative sales, negative net assets, negative dividends, negative capital expenditures and firms from the financial (SIC 6000-6999) and utility (SIC 4900-4999) industries. Firm characteristics include total assets, sales, percentage change in sales, tobin's q, cash, leverage, profitability, capital expenditures, cash acquisitions, and R&D expenses. All dollar values are adjusted to 2013 dollars using the consumer price index. Cash, leverage, profitability, capital expenditures, cash acquisitions, and R&D expenses are deflated by total assets. CEO characteristics include age, vega and delta. Vega and delta are deflated by CEO's total compensation. t-tests (Wilcoxon-Mann-Whitney tests) are conducted to test for differences between means (medians) for firms with overconfident vs. rational CEOs. CEO overconfidence is based on a longholder measure. *** and ** denote statistically significant difference at the 1% and 5% levels, respectively.

3. CEO overconfidence and the value of cash

3.1. Baseline estimate

To measure the impact of CEO overconfidence on the value of cash holdings, we adopt the valuation model suggested by Faulkender and Wang (2006). This model examines whether a change in cash holdings leads to a change in firm value. We augment the Faulkender and Wang's (2006) baseline model with our overconfidence variable and its interaction with the change in cash holding variable. Specifically, we estimate the following equation:

$$r_{i,t} - R_{i,t}^B = \gamma_0 + \beta_1 \frac{\Delta C_{i,t}}{M_{i,t-1}} + \beta_2 \text{Overconfident CEO (Options)}_{i,t} + \beta_3 \text{Overconfident CEO (Options)}_{i,t} \times \frac{\Delta C_{i,t}}{M_{i,t-1}} + \gamma'X + \varepsilon_{i,t} \quad (1)$$

where the dependent variable is firm i 's excess return from year $t-1$ to year t , which corresponds to the difference between firm i 's stock return and the return of firm i 's benchmark portfolio over the same period. Following Daniel and Titman (1997), the benchmark portfolios are the Fama-French (1993) 25 value-weighted portfolios constructed by independent sorting stocks on size and book-to-market characteristics.⁸ $\Delta C_{i,t}$ is the change in cash holdings from year $t-1$ to year t . Following Faulkender and Wang (2006), $\Delta C_{i,t}$ is scaled by the market value of equity at the end of the previous year ($M_{i,t-1}$). This procedure allows to interpret the coefficient β_1 as the dollar change in shareholder wealth for a one-dollar change in cash holdings. $\text{Overconfident CEO}_{i,t}$ is the longholder proxy for CEO overconfidence. The vector X includes the set of firm-specific characteristics from the Faulkender and Wang's baseline model in order to control for changes in firms' profitability, financial policy, and investment policy. These firm-specific control variables are: (1) $\Delta E_{i,t}$, the change in earnings before extraordinary items; (2) $\Delta NA_{i,t}$, the change in net assets; (3) $\Delta RD_{i,t}$, the change in research and development expenses; (4) $\Delta I_{i,t}$, the change in interest expenses; (5) $\Delta D_{i,t}$, the change in common dividends; (6) $NF_{i,t}$, the firm's net financing; and (7) $C_{i,t-1}$, the firm's cash holdings at the end of the previous year. All these variables are scaled by the market value of equity at the end of the previous year ($M_{i,t-1}$). The specification includes also the market leverage of the firm ($L_{i,t}$), the interaction between $\Delta C_{i,t}/M_{i,t-1}$ and $C_{i,t-1}/M_{i,t-1}$, and the interaction between $L_{i,t}$ and $\Delta C_{i,t}/M_{i,t-1}$.

In Eq. (1), β_2 measures the direct effect of CEO overconfidence on excess stock returns, while β_3 , our coefficient estimate of interest, measures the impact of CEO overconfidence on the marginal value of cash. A significantly positive (negative) β_3 coefficient indicates that an additional one dollar of cash holding is worth more (less) for firms managed by overconfident CEOs relative to firms managed by rational CEOs.

We estimate Eq. (1) after including year and industry fixed effects to control for time and industry trends on excess returns. In addition to reduce the impact of influential observations we winsorize all continuous variables at the 2.5th and 97.5th percentiles.⁹ Panel A of Table 3 reports the results. In specification (1) we use the baseline model of Faulkender and Wang (2006), whereas in specification (2) we further control for the age of the CEO, as well as the stock price sensitivity (*delta*) and the stock return volatility sensitivity (*vega*) of the CEO's incentive compensation, and the interaction terms of age, delta and vega with $\Delta C_{i,t}$. In specification (3), we re-run the same specification as in specification (2) but we group overconfident CEOs into low versus high degree of confidence. The variables of interest in this specification are the interaction terms between low and high CEO confidence and the change in cash holdings.

The results show that having overconfident CEOs on board significantly increases the value of a dollar of cash both economically and statistically, as indicated by the positive and significant coefficient on the interaction between the change in cash and overconfident CEO in specifications (1) and (2). The coefficient estimate of the interaction term in specification (1) indicates that the value that the stock market assigns to a dollar of cash is \$0.29 greater for a firm managed by an overconfident CEO relative to a firm run by a rational CEO ($p < .01$). Similarly, the corresponding value in specification (2) with the full set of controls is \$0.28 ($p < .01$). Finally, in specification (3) the results show that high CEO confidence rather than low CEO confidence drives the previous relation between CEO overconfidence and the value of cash. Particularly, relative to rational CEOs, the value that the stock market assigns to a dollar of cash is \$0.31 greater for a firm with a high confident CEO ($p < .01$). For low confident CEOs the stock market does not assign a different dollar of cash relative to rational CEOs.

Panel B of Table 3 reports the marginal value of cash for the average firm in the full sample as well as conditional on the CEO being classified as overconfident or not. To estimate the corresponding marginal value, we use the coefficient estimates on the change in cash and each coefficient that is interacted with the change in cash in Panel A of Table 3. Specifically, to compute the marginal value of a change in cash for the average firm we start with the coefficient estimate of the change in cash and add the product between the respective coefficients on the cash change interactions and the sample means of the interaction variables. Using the

⁸ Each sample firm is assigned to size and book-to-market portfolios using the size and book-to-market breakpoints obtained from Kenneth French's website (<http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/>).

⁹ We obtain qualitatively similar results without any winsorization or by changing the winsorization thresholds. We use the 2.5% winsorization threshold throughout the paper in order to have more consistent result with prior literature for the marginal value of cash holding. Decreasing (increasing) the threshold increases (decreases) the marginal value of cash for the average firm but does not qualitatively affect the relation between CEO overconfidence and the marginal value of cash.

Table 3
CEO Overconfidence and the Value of Cash.

Panel A. OLS Regressions						
	(1)		(2)		(3)	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
ΔC_t	1.547***	18.04	1.997***	5.92	1.987***	5.92
Overconfident _t	-0.047***	-5.93	-0.045***	-5.78		
$\Delta C_t \times$ Overconfident _t	0.285***	2.89	0.279***	2.85		
Low confidence _t					-0.044***	-3.56
$\Delta C_t \times$ Low confidence _t					0.187	1.43
High confidence _t					-0.046***	-5.17
$\Delta C_t \times$ High confidence _t					0.311***	2.87
ΔE_t	0.465***	13.40	0.461***	13.27	0.604***	10.08
ΔNA_t	0.203***	10.50	0.203***	10.53	0.210***	8.02
ΔRD_t	0.934	2.36	0.876**	2.22	0.772	1.29
ΔI_t	-2.354***	-4.95	-2.343***	-4.94	-3.035***	-4.83
ΔD_t	0.419	1.11	0.456	1.22	0.531	1.25
NF_t	-0.144***	-3.71	-0.153***	-3.96	-0.148***	-2.70
C_{t-1}	0.394***	13.00	0.385***	12.79	0.491***	10.37
L_t	-0.404***	-19.05	-0.392***	-18.29	-0.437***	-16.53
$\Delta C_t \times C_{t-1}$	-0.812***	-4.38	-0.797***	-4.33	-0.783***	-3.06
$\Delta C_t \times L_t$	-1.312***	-6.56	-1.252***	-6.15	-1.880***	-6.64
CEO age			-0.001	-1.09	-0.001	-1.09
$\Delta C_t \times$ CEO age			-0.009	-1.44	-0.008	-1.39
Vega/TC			-0.675***	-6.30	-0.673***	-6.28
$\Delta C_t \times$ (Vega/TC)			-0.399	-0.22	-0.433	-0.24
Delta/TC			0.040***	4.78	0.040***	4.77
$\Delta C_t \times$ (Delta/TC)			0.051	0.28	0.060	0.33
Intercept	0.070***	2.76	0.104***	2.91	0.103	2.91
Year fixed effects	Yes		Yes		Yes	
Industry fixed effects	Yes		Yes		Yes	
Adjusted R ²	0.200		0.205		0.205	
Observations	12,105		12,105		12,105	

Panel B. The Marginal Value of Cash for the Average Firm			
Sample Means			
C_{t-1}	0.132	0.132	0.132
L_t	0.178	0.178	0.178
Overconfident _t	0.277	0.277	0.277
CEO age		54.928	54.928
Vega/TC		0.028	0.028
Delta/TC		0.211	0.211
Low confidence _t			0.069
High confidence _t			0.208
Value of \$1			
Full sample	1.29	1.25	1.29
Overconfident _t	1.49	1.45	
High confidence _t			1.54
Rational _t	1.21	1.17	1.23

This table reports OLS regressions to estimate the value of cash using the [Faulkender and Wang \(2006\)](#) approach. The sample consists of 12,105 firm-year observations and covers the period 1993–2013. To be included in the sample, firms are required to belong in the S&P 1500 index with available observations in the ExecuComp, CRSP, and Compustat databases. In addition, we exclude firm-years with market value of equity < 25 million in constant 2013 dollars, negative sales, negative net assets, negative dividends, negative capital expenditures and firms from the financial (SIC 6000-6999) and utility (SIC 4900-4999) industries. The dependent variable is the annual excess return of the firm relative to the [Fama and French \(1993\)](#) twenty-five value weighted size and book-to-market portfolios. CEO overconfidence, low and high confidence are based on a longholder measure (see Appendix A). Δ indicates the change from the previous year. C_t is cash holding, E_t is earnings before interest and extraordinary items, NA_t is total assets minus cash holdings, RD_t is research and development expenses, I_t is interest expenses, D_t is common dividends, L_t is market leverage, and NF_t is net financing. TC is the CEO's total compensation in a given year. $Delta$ and $Vega$ are the stock price sensitivity and the stock return volatility sensitivity of the CEO's incentive compensation, respectively. Variable definitions are in Appendix A. Standard errors are adjusted for heteroskedasticity and firm clustering. ***, ** and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. Panel B uses the mean (in-sample for each regression) levels of C_{t-1} , L_t , $Overconfident_t$, CEO age, $Delta/TC$, $Vega/TC$, low confidence and $high$ confidence to compute the marginal value of \$1 in cash for the average firm in the full sample, and conditional on the CEO being overconfident (highly confident) or not.

Table 4
Controlling for Firm Fixed Effects.

	(1)	(2)
ΔC_t	1.865*** (5.59)	1.864*** (5.59)
Overconfident _t	−0.031 (−1.14)	
$\Delta C_t \times \text{Overconfident}_t$	0.206** (2.10)	
Low confidence _t		−0.027 (−0.80)
$\Delta C_t \times \text{Low confidence}_t$		0.182 (1.42)
High confidence _t		−0.032 (−1.00)
$\Delta C_t \times \text{High confidence}_t$		0.214*** (1.98)
Firm fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Control variables	Yes	Yes
Adjusted R ²	0.269	0.269
Observations	12,105	12,105

This table presents coefficient estimates of specifications (2) and (3) of Table 3 after controlling for firm fixed-effects. The dependent variable is the annual excess return of the firm relative to the Fama and French (1993) twenty-five value weighted size and book-to-market portfolios. CEO overconfidence, low and high confidence are based on a longholder measure. Variable definitions are in Appendix A. Standard errors are adjusted for heteroskedasticity and firm clustering. *T*-statistics are reported within brackets below the corresponding coefficient estimates. ***, ** and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

coefficient estimates in specification (1), we find that a dollar of cash is worth approximately \$1.29 for the average firm in our sample.^{10,11} The corresponding value is \$1.25 in specification (2) with the full set of controls, and \$1.29 in specification (3) when splitting the sample into high and low confident CEOs, respectively; this suggests that the (unconditional) marginal value of cash for the average firm in the sample is not materially affected by the inclusion of the CEO-specific control variables into the specification. However, the marginal value of cash can increase to \$1.45–\$1.49 if the firm is managed by an overconfident CEO (see specifications (1) and (2)), or to \$1.54 if it is managed by a high confident CEO (see specification (3)). Alternatively, an additional one dollar of cash holding in a firm managed by a rational CEO is worth substantially less, with a value that ranges between \$1.17–\$1.23 (see specifications (1) through (3)).

In summary, the results indicate that having overconfident CEOs on board is associated with a positive impact on the marginal value of cash. This finding suggests that the costly external finance hypothesis dominates the overinvestment hypothesis for the average firm with an overconfident CEO.

3.2. Robustness checks

In this section, we perform several additional tests to assess the robustness of our results.

3.2.1. Controlling for firm fixed effects

In addition to the large set of control variables we use in the analysis, including firm fixed effects allows us to control for unobserved firm heterogeneity. However, consistent with the theory that overconfidence is a persistent trait, the option-based measure of CEO overconfidence is a CEO fixed effect. So, examining the direct effect of CEO overconfidence on firm value (i.e., excess return) using a firm fixed effect model is impossible because the CEO overconfidence effect on firm value is subsumed by the firm fixed effects; only when there is within-firm variation of CEO overconfidence (i.e., when the overconfidence classification of a newly hired CEO is different from the classification of the previous CEO) it is possible to control for firm fixed effects – but this may induce sample selection bias. Fortunately, in our setting we are interested on whether the marginal value of cash is different between firms with overconfident and rational CEOs. This cross-sectional difference in the value of cash between overconfident and rational CEOs is captured by the coefficient estimate (β_3) of the interaction term $\Delta C_t \times \text{Overconfident}_t$. Since the first term in the interaction variable

¹⁰ The marginal value of cash is calculated as follows (in \$): $1.547 + (0.285 * 0.277) + (-0.812 * 0.132) + (-1.312 * 0.178) = 1.29$.

¹¹ In comparison, Faulkender and Wang (2006) report a marginal value of cash of \$0.94. The difference between our estimate and theirs is likely due to the differences in the sample periods and the fact that we only consider firms included in the ExecuComp database with equity value higher than \$25 million, while Faulkender and Wang (2006) use firms included in Compustat with positive equity value. The other sample selection criteria are similar. In Appendix B, we estimate model (1) using the period 1972–2001 (i.e., sample period in Faulkender and Wang (2006)) and applying our sample selection criteria. In this sample, the marginal value of cash is \$0.89, a figure very close to the estimate in Faulkender and Wang (2006). In Appendix B, models (2) and (3) compare for the same sample period (from 1993 to 2013) a sample of observations extracted from Compustat with a sample from ExecuComp using our initial filters. The marginal value of cash increases from \$1.25 to \$1.34. In model (4) of Appendix B, we estimate the baseline model (specification (2) in Table II) of Faulkender and Wang (2006) using the sample of observations for which the overconfidence variable is available. For this sample, the marginal value of cash is \$1.32. Hence, the discrepancy between our estimate and the one of Faulkender and Wang (2006) has primarily two sources: the sample period and the data source. Bates et al. (2018) also document an increasing trend in the value of cash over time.

is time-varying, its effect on firm value can be estimated using a firm fixed effects model.

Therefore, to control for unobserved time-invariant firm heterogeneity, we re-run the specifications (2) and (3) of Table 3, after controlling for firm fixed effects. If the estimated effects of CEO overconfidence in Table 3 are entirely due to firm fixed effects, the coefficient estimates should decline substantially in value and become insignificant when we include firm fixed effects. Specifications (1) and (2) in Table 4 report the results. The results show that the interaction terms of CEO overconfidence with the change in cash still carry positive and significant coefficients. Most importantly, as expected the magnitudes are slightly lower in comparison to the ones reported in Table 3, but the effect of CEO overconfidence on the marginal value of cash remains substantial. The coefficient estimate of the interaction term is 0.21, and indicates that the cross-sectional difference in the marginal value of cash between overconfident and rational CEOs is \$0.21.

3.2.2. Propensity score matching

If firms with overconfident CEOs are fundamentally different from those with rational CEOs, then the control variables employed in the main specification that capture linear relations may be inadequate. Under this assumption, the results could be biased and may pick up non-linear effects of the control variables on firm value. To alleviate concerns over such functional form misspecification biases, we create two data samples that are comparable across all the control variables, but differ only on whether the CEO is overconfident or rational. To construct these samples, we implement a propensity score matching (PSM) process following Drucker and Puri (2005) and match firms with overconfident CEOs in our sample with firms exhibiting similar characteristics but have rational CEOs on board. Specifically, the method consists of a probit regression to estimate propensity scores, $p(Y = 1/X = x)$, based on the probability of receiving a binary treatment, Y , conditional on all the control variables, x . In our setting, we consider having an overconfident CEO as treatment and we estimate the probability of having an overconfident CEO using the independent variables based on the specification (2) of Table 3 (without including interaction terms of change in cash).¹² Then, for each firm-year with an overconfident CEO we use the propensity score to find a comparable firm-year with a rational CEO based on the nearest-neighbor method. To ensure the adequacy of the matching estimation method, we require that the absolute difference in propensity scores among pairs does not exceed 0.05. If there are more firms-years with a rational CEO that meet this criterion, we retain the firm-year with the smallest difference in the propensity scores. Using this approach, we find 3356 unique pairs of matched firms-years.

Panel A of Table 5 reports the difference-in-means of the independent variables for overconfident and rational CEOs for both the unmatched and matched samples, respectively. The t -statistics of the corresponding difference-in-means indicate that many variables differ significantly for the unmatched sample. As expected, however, almost all the considered independent variables are comparable for the matched sample; the only exception is the variable Vega/TC for which the difference-in-mean is statistically significant at the 10% level. Using this matched sample in Panel B of Table 5, we re-run the regressions as in models (2) and (3) of Table 3. The results remain robust reaffirming that the CEO overconfidence effect is not an artifact of functional form misspecification biases.¹³

3.2.3. Alternative measures of overconfidence

The main analysis uses an option-based measure of CEO overconfidence based on revealed beliefs as captured by CEOs' personal portfolio decisions that are overexposed to the idiosyncratic risk of their firms. We replicate our main analysis by using alternative proxies of CEO overconfidence based on: (i) outsiders' perceptions of the CEO; and (ii) CEO/CFO gender. First, following Malmendier and Tate (2008) and Hirshleifer et al. (2012), we use a press-based measure of CEO overconfidence that we label *overconfident CEOs (press)* relying on hand-collected information from financial press articles over the period from 1992 to 2009. We use the available unique company code in Factiva to search for articles with keywords “the name or variants of the name of the CEO” during her tenure period in the following financial media: *New York Times*, *Business Week*, *Financial Times*, *The Times*, *Wall Street Journal*, *The Economist*, *Fortune*, *Forbes*, *Dow Jones Business News*, and *Dow Jones Online News*. Information about the name and tenure of CEOs comes from the Standard and Poor's ExecuComp.

For each CEO and year, we record the total number of relevant articles with the following information: (i) articles containing the words “confident”, “confidence” or variants such as “overconfidence” and “over-confident”, (ii) the number of articles containing the words “optimistic”, “optimism” or variants such as “overoptimistic”, “over-optimism”, (iii) the number of articles using “pessimistic”, “pessimism” or variants such as “over-pessimistic”, and (iv) the number of articles using “cautious”, “reliable”, “steady”, “practical”, “conservative”, “frugal”, “not confident” or “not optimistic” (or variants such as “not-confident” or “not-optimistic”). Each article has been carefully read to verify that the context of “confident/optimistic” or “pessimistic/cautious” characterizations are used in an appropriate manner and are only relevant to the CEO and company of interest. Our financial press-based overconfidence measure classifies a CEO as overconfident if the number of press articles describing the manager as “confident/optimistic” exceeds the number of articles describing the manager as “pessimistic/cautious”. In particular, we compare the number of articles that use the “confident/optimistic” terms as captured by categories (i) and (ii) and articles that use the “pessimistic/cautious” terms, as captured by categories (iii) and (iv) and measure CEO overconfidence for each CEO i in year t as:

¹² The results are robust to using the exact specification (2) of Table 3.

¹³ Endogeneity arising from a potential positive relation between CEO overconfidence and high stock returns may complicate our analyses and results. In section 3.3.2 we explicitly discuss and address such concerns using various approaches. A complementary approach that mitigates endogeneity concerns would be to use the firm's stock return as an additional criterion in the propensity score matching procedure to ensure that stock returns between overconfident CEO and rational CEO firm-years are not statistically different. When we do so, untabulated results show that our main findings remain robust.

Table 5
Propensity Score Matching.

Panel A: Difference-in-Means of Control Variables Between the Overconfident and Rational CEO Subsamples				
	Unmatched sample		Matched sample	
	Difference-in-Means	t-stat	Difference-in-Means	t-stat
ΔC_t	0.005***	2.80	0.000	0.18
ΔE_t	-0.001	-0.31	0.001	0.34
ΔNA_t	0.049***	8.83	0.001	0.14
ΔRD_t	0.001***	4.22	-0.000	-0.07
ΔI_t	0.001***	3.09	0.000	0.93
ΔD_t	0.001***	3.97	-0.000	-0.11
C_{t-1}	-0.075***	-24.04	-0.001	-0.21
L_t	-0.044***	-12.21	0.001	0.25
NF_t	0.003	1.14	0.000	0.16
CEO age	0.006	0.04	-0.225	-1.25
Vega/TC	-0.001	-1.16	0.001*	1.88
Delta/TC	0.025**	2.31	0.003	0.24
Observations				
All sample	12,105		6712	
Overconfident	3356		3356	
Rational	8749		3356	

Panel B: CEO Overconfidence and the Value of Cash: Matched Sample			
	(1)	(2)	
ΔC_t	1.657*** (4.23)	1.650*** (4.23)	
Overconfident _t	-0.049*** (-5.45)		
$\Delta C_t \times$ Overconfident _t	0.307*** (2.81)		
Low confidence _t		-0.046*** (-3.44)	
$\Delta C_t \times$ Low confidence _t		0.250* (1.75)	
High confidence _t		-0.049*** (-5.07)	
$\Delta C_t \times$ High confidence _t		0.323*** (2.73)	
Control variables	Yes	Yes	
Year fixed effects	Yes	Yes	
Industry fixed effects	Yes	Yes	
Adjusted R ²	0.239	0.239	
Observations	6712	6712	

Panel A presents for each control variable in Table 3 the difference-in-means between the overconfident and rational CEO subsamples together with the corresponding t-statistics. The unmatched sample corresponds to the original sample. The matched sample is the sample based on CEO overconfidence propensity score matching. Panel B presents coefficient estimates of specifications (2) and (3) of Table 3 using the matched sample. The dependent variable is the annual excess return of the firm relative to the Fama and French (1993) twenty-five value weighted size and book-to-market portfolios. CEO overconfidence, low and high confidence are based on a longholder measure. Variable definitions are in Appendix A. Standard errors are adjusted for heteroskedasticity and firm clustering. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

$$OV_{it} = \begin{cases} 1 & \text{if } \sum_{i=1}^t CONF_{ij} > \sum_{q=1}^t CAUT_{ij} \\ 0 & \text{otherwise} \end{cases}, \tag{2}$$

where $CONF_{ij}$ is the number of articles using the “confident” terms and $CAUT_{ij}$ is the number of articles using the “cautious” terms. Our press-based measure cumulates articles starting from the first year the CEO is in office.¹⁴ Note that this measure allows a CEO to change from being overconfident to rational when the number of articles using the “cautious” terms is greater than the number of articles using the “confident” terms during a certain year.¹⁵ We run the same regression as in specification (2) of Table 3 including also the variable CEO articles and its interaction with the change in cash holdings as an additional control. Specification (1) of Table 6

¹⁴ Standard and Poor's ExecuComp provides information about CEOs since 1992. From this information, it seems that many CEOs in our sample are in the office well before 1992. Thus, to avoid time bias truncation from omitted articles that characterizes CEOs prior to 1992, our article searches start from the first date the CEO is in the office.

¹⁵ Since overconfidence is a persistent trait, as a robustness analysis, we have also used a time-invariant press-based proxy for CEO overconfidence. More precisely, once the CEO is classified as being overconfident using the press measure, he/she keep the classification for all the remaining CEO tenure. Unreported results remain qualitatively similar.

Table 6
Alternative Measures of CEO Overconfidence.

	(1)	(2)
ΔC_t	2.514*** (8.15)	2.412*** (7.76)
Overconfident (Press) _t	-0.022** (-2.42)	
$\Delta C_t \times$ Overconfident (Press) _t	0.221** (1.97)	
Overconfident (Gender) _t		0.003 (0.26)
$\Delta C_t \times$ Overconfident (Gender) _t		0.248* (1.81)
Year fixed effects	Yes	Yes
Industry fixed effects	Yes	Yes
Control variables	Yes	Yes
Adjusted R ²	0.222	0.219
Observations	16,902	15,967

This table reports OLS regressions to estimate the value of cash using the [Faulkender and Wang \(2006\)](#) approach as per specification (2) of [Table 3](#). To be included in the sample, firms are required to belong in the S&P 1500 index with available observations in the ExecuComp, CRSP, and Compustat databases. In addition, we exclude firm-year observations with market value of equity < 25 million in constant 2009 dollars, negative sales, negative net assets, negative dividends, negative capital expenditures and firms from the financial (SIC 6000-6999) and utility (SIC 4900-4999) industries. The dependent variable is the annual excess return of the firm relative to the [Fama and French \(1993\)](#) twenty-five value weighted size and book-to-market portfolios. Overconfidence is based on a press measure (period 1992–2009) and a gender measure (period 1993–2013). Δ indicates the change from the previous year. C_t is cash holding. Variable definitions are in Appendix A. Standard errors are adjusted for heteroskedasticity and firm clustering. *T*-statistics are reported within brackets below the corresponding coefficient estimates. ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

reports the results. Largely, the findings with the press-based proxy echo those obtained with the stock option-based measure in [Table 3](#).

Second, following [Barber and Odean \(2001\)](#) and [Huang and Kisgen \(2013\)](#) we use a gender-based measure of overconfidence. [Barber and Odean \(2001\)](#) provide evidence that men are more overconfident than women and this behavior is reflected in relatively more aggressive stock trades and lower returns. Similarly, [Huang and Kisgen \(2013\)](#) show that male executives undertake more acquisitions and issue debt more often than female executives, attributing these findings to managerial overconfidence. Thus, we rely on ExecuComp's classification (data item Gender = Male) to identify male/female CEOs. In line with [Huang and Kisgen's \(2013\)](#) approach, since the percentage of male CEOs in the sample is too high for a meaningful analysis, we also consider the gender of CFOs in order to increase the power of our test. Both executives play a significant role in major investment/financing decisions, which, as per our theoretical perspective, determine the value of cash. We label this measure as *overconfident (Gender)* and report the results in specification (2) of [Table 6](#). Again, the results show that executive overconfidence positively affects the value of cash. Overall, our results corroborate our main findings and remain robust to the measure of overconfidence employed.

3.2.4. Controlling for corporate governance

Prior literature provides evidence that the quality of firm's corporate governance relates to its cash policy. For instance, [Pinkowitz et al. \(2006\)](#), [Dittmar and Mahrt-Smith \(2007\)](#) and [Kalcheva and Lins \(2007\)](#) document a positive association between good corporate governance and the value of cash. Thus, to attenuate potential omitted variable bias, we estimate augmented regression models in which we control for firm's governance structure.¹⁶ [Table 7](#) presents the results. In specification (1) we control for the [Bebchuk et al. \(2009\)](#) entrenchment index. The entrenchment index is the sum of binary variables concerning the following provisions: (i) classified boards; (ii) limitations to shareholders' ability to amend the bylaws; (iii) supermajority voting for business combinations; (iv) supermajority requirements for charter amendments; (v) poison pills; and (vi) golden parachutes. A high entrenchment index value represents strong managerial power. Accordingly, in our specification we use a dummy variable, *good governance*, to identify firms with low managerial power. These are sample firms that belong to the bottom tercile of the entrenchment index. In specification (3), we include a control for the board structure. We use an indicator variable identifying firms-years in which the CEO of the firm is also the chairman of the board (i.e., duality). CEO duality is associated with weak governance ([Dahya et al. \(2002\)](#)). Finally, in specification (5) we include controls for the ownership structure. Following [Bushee \(1998\)](#), we include the percentage of institutional holdings by dedicated investors (DED), the percentage of institutional holdings by quasi indexers investors (QIX), and the percentage of institutional holdings by transient investors (TRA).¹⁷ Overall, the main findings remain robust to the inclusion of these variables. Additionally, in specifications (2), (4) and (6), we run similar regressions to specifications (1), (3), and (5), respectively, but this time by partitioning CEOs by degree of confidence. The results are similar and the impact of CEO overconfidence on the value of cash is more pronounced in firms with high confident CEOs.

¹⁶ We report these results in this section rather than in the main analysis because many of these variables, due to data availability, reduce the sample size.

¹⁷ Information about the type of institutional investors is from Brian Bushee's website (<http://acct.wharton.upenn.edu/faculty/bushee/Iclass.html>).

Table 7
Controlling for Corporate Governance.

	Entrenchment Index		CEO/Chairman Duality		Institutional Ownership	
	(1)	(2)	(3)	(4)	(5)	(6)
ΔC_t	2.083*** (5.06)	2.077*** (5.09)	2.075*** (5.90)	2.064*** (5.90)	1.642*** (4.26)	1.643*** (4.26)
Overconfident _t	−0.051*** (−5.64)		−0.046*** (−5.79)		−0.048*** (−5.96)	
$\Delta C_t \times$ Overconfident _t	0.277** (2.42)		0.273*** (2.78)		0.252*** (2.69)	
Low confidence _t		−0.052*** (−3.77)		−0.044*** (−3.57)		−0.039*** (−3.26)
$\Delta C_t \times$ Low confidence _t		0.213 (1.43)		0.188 (1.47)		0.204 (1.62)
High confidence _t		−0.050*** (−4.91)		−0.046*** (−5.17)		−0.051*** (−5.49)
$\Delta C_t \times$ High confidence _t		0.297** (2.38)		0.302*** (2.78)		0.266** (2.50)
Good governance _t	−0.012 (−1.55)	−0.012 (−1.55)				
$\Delta C_t \times$ Good governance _t	0.279** (2.26)	0.281** (2.28)				
Duality _t			0.001 (0.17)	0.001 (0.18)		
$\Delta C_t \times$ Duality _t			0.149 (1.52)	0.146 (1.50)		
DED _t					0.064 (1.42)	0.066 (1.46)
$\Delta C_t \times$ DED _t					0.955 (1.64)	0.939 (1.60)
QIX _t					−0.167*** (−7.11)	−0.167*** (−7.09)
$\Delta C_t \times$ QIX _t					−0.544* (−1.95)	−0.551** (−1.96)
TRA _t					0.623*** (16.94)	0.624*** (16.98)
$\Delta C_t \times$ TRA _t					0.647* (1.70)	0.638* (1.67)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R ²	0.203	0.203	0.206	0.205	0.230	0.230
Observations	9336	9336	12,105	12,105	11,614	11,614

This table presents coefficient estimates of specifications (2) and (3) of Table 3 after controlling for the quality of the firm's corporate governance. The dependent variable is the annual excess return of the firm relative to the Fama and French (1993) twenty-five value weighted size and book-to-market portfolios. CEO overconfidence, low and high confidence are based on a longholder measure (See Appendix A). Specifications (1) and (2) include *Good governance* as an indicator variable that equals 1 when the Bebchuk et al. (2009) Entrenchment Index from RiskMetrics belongs in the bottom tercile of the index. The index is the sum of binary variables concerning the following provisions: 1) classified boards; 2) limitations to shareholders' ability to amend the bylaws; 3) supermajority voting for business combinations; 4) supermajority requirements for charter amendments; 5) poison pills; and 6) golden parachutes. Specifications (3) and (4) control for CEO/Chairman duality using an indicator variable that equals to 1 when the CEO of the firm is also the chairman of the board, and 0 otherwise. Specifications (5) and (6) control for the percentage of institutional holdings by dedicated investors (DED), the percentage of institutional holdings by quasi indexers investors (QIX), and the percentage of institutional holdings by transient investors (TRA). Information about the type of institutional investors is from Brian Bushee's website. For the sake of brevity, the coefficient estimates of the control variables are not reported. Variable definitions are in Appendix A. Standard errors are adjusted for heteroskedasticity and firm clustering. *T*-statistics are reported within brackets below the corresponding coefficient estimates. ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

3.2.5. Controlling for cash regimes

In a recent study, Halford et al. (2017) emphasize the importance of controlling for cash regimes identified by Faulkender and Wang (2006) when estimating the value of cash. Prior literature mostly ignores cash regimes and that omission may lead to erroneous conclusions about the relations between firm/CEO characteristics and the value of cash. In this subsection, we assess whether our main result survives once we control for cash regimes.

According to the foundational theory of Faulkender and Wang (2006), the marginal value of cash is expected to be a function of the firm's cash regime. In particular, the marginal value of cash is likely to be higher in a firm that requires external capital to fund valuable projects (i.e., raising cash regime) in comparison to a firm with excess cash to distribute to shareholders (i.e., distributing cash regime).¹⁸ Intuitively, we expect the costly external finance hypothesis to be most relevant in the raising cash regime, and the overinvestment hypothesis to dominate in the distributing cash regime.

In Table 8, we run the same regression as in specification (2) of Table 3 while controlling explicitly whether the firm is in the raising cash or distributing cash regime. We follow Halford et al. (2017) to identify cash regimes, that is, we rely on actual firm behaviors.¹⁹ In a given year, a firm is classified in the raising cash regime, if it issues equity for a value that is > 3% of the market

¹⁸ In our sample, the marginal value of cash is indeed higher in the raising cash regime, and the difference in value with the distribution regime is \$0.56 (unreported result). These estimates are in line with the foundational theory.

¹⁹ Relying on the definition of cash regimes as in Faulkender and Wang (2006), yields a statistically significant CEO overconfidence effect on the marginal value of cash. Nevertheless, the sample size within regimes is very small; therefore, we choose to present and discuss the results based on the definition of cash regimes as in Halford et al. (2017).

Table 8
Controlling for Cash Regimes.

	Raising cash regime		Distributing cash regime	
	(1)	(2)	(3)	(4)
ΔC_t	2.061** (2.42)	2.066** (2.41)	1.876*** (4.17)	1.885*** (4.14)
Overconfident _t	-0.085* (-1.90)		-0.047*** (-5.59)	
$\Delta C_t \times$ Overconfident _t	0.633*** (2.49)		0.183 (1.36)	
Low confidence _t		-0.078 (-1.11)		-0.057*** (-4.63)
$\Delta C_t \times$ Low confidence _t		0.660** (2.18)		0.177 (1.13)
High confidence _t		-0.086* (-1.73)		-0.044*** (-4.41)
$\Delta C_t \times$ High confidence _t		0.627** (2.23)		0.188 (1.18)
Industry fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes
Adjusted R ²	0.370	0.367	0.182	0.182
Observations	534	534	8382	8382

This table presents coefficient estimates of specifications (2) and (3) of Table 3 after controlling for cash regimes. The dependent variable is the annual excess return of the firm relative to the Fama and French (1993) twenty-five value weighted size and book-to-market portfolios. CEO overconfidence, low and high confidence are based on a longholder measure. Following Halford et al. (2017), cash regimes are defined using actual firm behaviors. Columns (1) and (2) restrict the sample to firms classified in the raising cash regime (i.e., firms that issue equity which is > 3% of the market value of equity and do not make dividend payments). Columns (3) and (4) restrict the sample to firms classified in the distributing cash regime (i.e., firms that distribute cash and do not issue equity). Variable definitions are in Appendix A. Standard errors are adjusted for heteroskedasticity and firm clustering. *T*-statistics are reported within brackets below the corresponding coefficient estimates. ***, ** and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

value of equity and does not make dividend payment.²⁰ In the same vein, a firm is classified in the distributing cash regime in a given year if it distributes cash to shareholders and does not belong to the raising cash regime. A firm distributes cash to shareholders when dividend payment is positive, or purchase of common and preferred stock is greater than equity issuance.

Columns (1) and (2) of Table 8 report the results for the subsample of firm-year observations in the raising cash regime. In column (1), the coefficient estimate of the interaction between CEO overconfidence and the change in cash is positive and significant, a result which is consistent with the costly external finance hypothesis. In economic terms, having an overconfident CEO in the raising cash regime increases the value of \$1.00 cash holding by an additional amount of \$0.63 relative to a firm run by a rational CEO in the same cash regime. Column (2) of Table 8 indicates that the effect is almost comparable for CEOs with low and high confidence. Columns (3) and (4) show the results for firm-year observations in the distributing cash regime. Interestingly, the effect of CEO overconfidence on the value of cash is statistically insignificant at conventional levels.

A closer investigation of the firms-years within the raising cash regime reveals that 43.25% (24.9%) are classified as externally (internally and externally) financially constrained.²¹ Thus, the results, clearly provide additional support for the costly external finance hypothesis and are in line with our main results in Table 3. Overall, controlling for the cash regimes does not alter our main conclusions pertaining the average firm run by an overconfident CEO.

3.3. Alternative explanations

3.3.1. Alternative interpretations of option based overconfidence proxy

In this section, we investigate whether the results are due to CEOs' characteristics that correlate with CEOs' option exercising behavior. Such characteristics include CEO ability and risk tolerance aptitudes. Particularly, more able CEOs are expected to perform better than less able CEOs. Thus, more able CEOs could also be inclined to refrain from option exercising and sale of the stock even if they are deep in the money. This implies that the relation between late exercisers and the value of cash may capture, besides overconfidence, superior CEO ability and expectations about positive performance in the future. To rule out such alternative interpretations, we augment the baseline specification with explicit controls for managerial ability and future stock performance. Panel A of Table 9 presents the results. Regarding managerial ability, we use in specifications (1) and (2) the index developed by Demerjian et al. (2012). This index is based on managers' efficiency in generating revenues. In specifications (3) and (4) we use the age of the CEO when she took first office. Falato et al. (2015) argue that more talented individuals will need less time on the corporate ladder to become CEOs. Finally, in specifications (5) and (6) we control for next year's stock returns. If late exercising correlates with expectations about future stock performance, then the CEO overconfidence effect should become smaller or cease to exist after controlling for future stock performance. Overall, in all specifications of Table 9, the results continue to show a positive relation between CEO overconfidence (i.e., late exercisers) and the value of cash, suggesting that neither managerial ability nor expectations about

²⁰ The cut-off point of 3% alleviates concerns over equity issuance which may result from employee-related exercising of stock options. Nevertheless, the results remain qualitatively similar if we rely on a 0% cut-off point (unreported).

²¹ See section 4.1 for the definitions of internal and external financial constraint status.

future stock performance drive this relation.

Additionally, more risk tolerant CEOs may also be reluctant to exercise their options and sell their stocks. At the same time, risk tolerant CEOs may implement riskier firm policies. Riskier firms, however, accumulate optimally higher cash reserves (Acharya et al. (2012)), which may imply a positive relation between risk and the value of cash. To preclude the possibility that the option-based measure of CEO overconfidence captures risk tolerant CEOs, we include additional controls for firm risk. We use controls for firms' credit risk and total risk. We measure credit risk: (i) using the probability of default calculated based on the Merton's (1974) model and applying the simplified "naive" approach suggested by Bharath and Shumway (2008) (specifications (1) and (2)); and (ii) using the interest coverage ratio (i.e., pretax income plus depreciation and amortization plus interest and related expenses, scaled by interest and related expenses) as an inverse proxy for credit risk (specifications (3) and (4)). Firms that do not pay interest are excluded from the analysis. Finally, we measure total risk using stock return volatility (specifications (5) and (6)). The results in Panel B of Table 9 indicate that controlling for firm risk, our findings remain qualitatively similar.

Table 9
Alternative Explanations for Late Option Exercisers.

Panel A: Managerial ability						
	Demerjian, Lev, McVay (DLM) (2012)		CEO Age at First Office		Expectations about Strong Future Performance	
	(1)	(2)	(3)	(4)	(5)	(6)
ΔC_t	2.096*** (6.19)	2.086*** (6.20)	1.922*** (5.17)	1.914*** (5.17)	1.993*** (5.86)	1.984*** (5.86)
Overconfident _t	-0.048*** (-6.10)		-0.047*** (-5.78)		-0.050*** (-6.17)	
$\Delta C_t \times$ Overconfident _t	0.283*** (2.85)		0.284*** (2.83)		0.251** (2.52)	
Low confidence _t		-0.046*** (-3.68)		-0.043*** (-3.45)		-0.047*** (-3.71)
$\Delta C_t \times$ Low confidence _t		0.194 (1.48)		0.197 (1.50)		0.174 (1.34)
High confidence _t		-0.049*** (-5.47)		-0.047*** (-5.21)		-0.051*** (-5.57)
$\Delta C_t \times$ High confidence _t		0.315*** (2.86)		0.315*** (2.83)		0.277** (2.51)
DLM _t	0.068*** (2.71)	0.068*** (2.71)				
$\Delta C_t \times$ DLM _t	-0.034 (-0.10)	-0.028 (-0.08)				
Age at first office			0.001 (0.08)	0.001 (0.07)		
$\Delta C_t \times$ Age at first office			0.007 (0.60)	0.007 (0.60)		
Return _{t+1}					-0.038*** (-3.91)	-0.038*** (-3.91)
$\Delta C_t \times$ Return _{t+1}					-0.122* (-1.75)	-0.121* (-1.74)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R ²	0.208	0.208	0.204	0.204	0.208	0.208
Observations	11,845	11,845	11,884	11,884	11,886	11,886

Panel B: Managerial Risk Tolerance						
	Probability of Default		Interest Coverage Ratio		Stock Return Volatility	
	(1)	(2)	(3)	(4)	(5)	(6)
ΔC_t	2.491*** (5.99)	2.457*** (5.91)	1.802*** (5.00)	1.796*** (5.01)	1.884*** (5.14)	1.873*** (5.13)
Overconfident _t	-0.043*** (-4.49)		-0.042*** (-5.01)		-0.044*** (-5.61)	
$\Delta C_t \times$ Overconfident _t	0.233** (1.96)		0.278*** (2.65)		0.259*** (2.58)	
Low confidence _t		-0.038*** (-2.74)		-0.043*** (-3.23)		-0.043*** (-3.45)
$\Delta C_t \times$ Low confidence _t		0.023 (0.15)		0.198 (1.45)		0.163 (1.22)
High confidence _t		-0.045*** (-4.04)		-0.042*** (-4.39)		-0.045*** (-5.03)
$\Delta C_t \times$ High confidence _t		0.315** (2.31)		0.305*** (2.64)		0.292*** (2.66)
Probability of default _t	-0.872*** (-3.07)	-0.872*** (-3.07)				
$\Delta C_t \times$ Probability of default _t	-2.718 (-1.03)	-2.495 (-0.94)				
Interest coverage _t			-0.001*** (-3.95)	-0.001*** (-3.95)		
$\Delta C_t \times$ Interest coverage _t			0.001** (2.21)	0.001** (2.21)		
Stock return volatility _t					-0.084 (-0.43)	-0.085 (0.44)
$\Delta C_t \times$ Stock return volatility _t					1.511 (1.06)	1.519*** (1.06)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

(continued on next page)

Table 9 (continued)

Panel B: Managerial Risk Tolerance						
	Probability of Default		Interest Coverage Ratio		Stock Return Volatility	
	(1)	(2)	(3)	(4)	(5)	(6)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R ²	0.185	0.185	0.210	0.210	0.207	0.207
Observations	8034	8034	10,620	10,620	12,090	12,090

This table presents coefficient estimates of specifications (2) and (3) of Table 3 after controlling for alternative explanations for late option exercisers. The dependent variable is the annual excess return of the firm relative to the Fama and French (1993) twenty-five value weighted size and book-to-market portfolios. CEO overconfidence, low and high confidence are based on a longholder measure (see Appendix A). In Panel A, specifications (1) and (2) control for CEO managerial ability using the measure developed by Demerjian, Lev, and McVay (DLM) (2012), specifications (3) and (4) control for the age the individual became first CEO and specifications (5) and (6) control for stock returns at year $t + 1$. For the sake of brevity, the coefficient estimates of the control variables are not reported. In Panel B, specifications (1) and (2) control for the probability of default as a proxy for credit risk. The probability of default is calculated based on the Merton's (1974) model of credit risk and the simplified "naive" approach suggested by Bharath and Shumway (2008). Specifications (3) and (4) include the interest coverage ratio as an inverse proxy for credit risk. Interest coverage ratio is calculated as pretax income plus depreciation and amortization plus interest expenses, scaled by interest expenses. The measure is set to missing value when interest expenses are zero or missing. The coefficient estimate of both the interest coverage ratio and the interaction term with change in cash holdings are multiplied by 100. Specifications (5) and (6) include stock return volatility as a proxy for total risk. Stock return volatility is measured using weakly returns during the entire fiscal year. We require at least 26 weakly returns during the year. Variable definitions are in Appendix A. Standard errors are adjusted for heteroskedasticity and firm clustering. *T*-statistics are reported within brackets below the corresponding coefficient estimates. ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

3.3.2. Non-random CEO-firm matching

Another possibility is that the positive association between CEO overconfidence and the value of cash is due to firm characteristics that correlate with the value of cash and induce firms to appoint overconfident CEOs. One approach to deal with non-random matching between CEO and firm due to latent firm characteristics is to analyze subsamples in which the matching issue is likely to be less severe (for a similar approach, see, Hirshleifer et al. (2012)). In particular, depending on the persistence of latent firm characteristics, matching should be stronger for recently appointed CEOs (i.e., these are CEOs with low tenures). We therefore re-examine the effects of CEO overconfidence on the value of cash for subsamples of CEOs with a certain level of tenure, eliminating from the sample firm-year observations of recently appointed CEOs. Because CEO overconfidence is a persistent trait whereas firm characteristics show less persistence and vary over time, these subsamples are more appropriate to identify the effect of CEO

Table 10
Non-Random CEO-Firm Matching.

	Tenure > 1 Year		Tenure > 3 Years		Tenure > 5 Years	
	(1)	(2)	(3)	(4)	(5)	(6)
ΔC_t	2.017*** (5.71)	2.005*** (5.72)	1.975*** (4.93)	1.943*** (4.88)	2.105*** (4.44)	2.059*** (4.43)
Overconfident _t	-0.047*** (-5.77)		-0.039*** (-4.39)		-0.038*** (-3.78)	
$\Delta C_t \times$ Overconfident _t	0.283*** (2.81)		0.255** (2.24)		0.306** (2.30)	
Low confidence _t		-0.041*** (-3.24)		-0.028* (-1.95)		-0.033** (-2.06)
$\Delta C_t \times$ Low confidence _t		0.176 (1.34)		0.104 (0.72)		0.003 (0.02)
High confidence _t		-0.048*** (-5.32)		-0.043*** (-4.29)		-0.040*** (-3.57)
$\Delta C_t \times$ High confidence _t		0.319*** (2.86)		0.307** (2.43)		0.412*** (2.88)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R ²	0.206	0.205	0.211	0.211	0.212	0.213
Observations	11,319	11,319	8942	8942	6906	6906

This table presents coefficient estimates of specifications (2) and (3) of Table 3 by subsamples of CEO tenure. Specifications (1) and (2) require CEO tenure > 1 year, specifications (3) and (4) > 3 years, and specifications (5) and (6) > 5 years. In all specifications the dependent variable is the annual excess return of the firm relative to the Fama and French (1993) twenty-five value weighted size and book-to-market portfolios. CEO overconfidence, low and high confidence are based on a longholder measure. For the sake of brevity, the coefficient estimates of the control variables are not reported. Variable definitions are in Appendix A. Standard errors are adjusted for heteroskedasticity and firm clustering. *T*-statistics are reported within brackets below the corresponding coefficient estimates. ***, **, and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

overconfidence on the value of cash that is largely free of any non-random CEO-firm matching bias. We consider three tenure cut-offs: strictly higher than one year, three years, and five years, respectively. Table 10 presents the results. Regardless the considered tenure cutoff point, the results show that the effect of CEO overconfidence on the marginal value of cash remains positive and statistically significant at conventional levels. Particularly the fact that the result holds almost with the same magnitude for CEOs with tenure of more than five years (see specifications (5) and (6)), should alleviate the possibility that the positive effect of CEO overconfidence on the value of cash comes from an endogenous selection of CEOs.

A second approach to deal with non-random matching between CEO and firm is to define specific firm characteristics that may drive this non-random matching. For instance, the board of firms with high stock returns may hire overconfident CEOs (e.g., “flamboyance begets flamboyance”). If stock returns positively relate to the value of cash, then our results could be spurious and simply reflect reverse causality. To address such reverse causality concerns, we initially identify all the newly hired CEOs in our sample. Then, we check if stock returns during the year of hiring were above the median stock returns across all firms-years. Finally, we exclude all firms-years where such CEOs manage the firm and re-run our main analysis using the remaining firms-years which are unlikely to relate to this type of reverse causality explanation. Untabulated results remain qualitatively similar; thus, reverse causality arising from high stock returns is very unlikely to drive our findings.

Stock returns may also give rise to a self-attribution bias explanation. Specifically, high stock returns may lead CEOs to become more overconfident. If so, and assuming that high stock returns positively relate with the value of cash, then our results could simply reflect an artifact of self-attribution bias and high stock returns (note that this is another type of reverse causality explanation). While difficult to decisively preclude this potential explanation, we re-run our main analysis using only firms-years where stock returns were less than the median value across the CEO tenure. Such years, however, most likely exhibit low growth opportunities and thus underinvestment by overconfident CEOs should be less important; therefore, we would naturally expect weaker results. Nevertheless, if we still find a positive relation between CEO overconfidence and the value of cash, then stock returns and self-attribution are less likely to drive our results. Untabulated results, although weaker, confirm our previous findings and interpretations.²²

4. Additional results

4.1. Costly external finance and overinvestment hypotheses

From a theoretical perspective, the availability of internal funds, and the tension between investment returns and perceived financing costs determine whether overconfident CEOs will tend to overinvest or underinvest (Malmendier and Tate (2005) and Malmendier et al. (2011)). Overconfident CEOs will overinvest when they have more than sufficient internal funds. If internal financing is insufficient, overconfident CEOs tap external financing and overinvest when the overestimated investment returns are larger than the perceived financing costs. This is more likely when the firm is also externally financially unconstrained because the (perceived) financing cost would be lower. In contrast, if internal financing is insufficient and the overestimated investment returns are larger than the perceived financing costs, then overconfident CEOs may underinvest. This is more likely when the firm is also externally financially constrained because the (perceived) financing cost would be greater.

Overall, the relation between CEO overconfidence and the value of cash depends on the availability of internal finance and the access to debt and equity markets; that is, it depends on firms' internal and external financial constraint status. Therefore, considering firm's financial constraint status allows us to explicitly examine the validity of the two hypotheses. Particularly, underinvestment is more likely when the firm has scarce resources (i.e., it is financially constrained), whereas overinvestment is more likely when the firm has abundant resources (i.e., it is financially unconstrained). Accordingly, under the costly external financing hypothesis a positive relation between CEO overconfidence and the value of cash should concentrate among financially constrained firms, whereas under the overinvestment hypothesis a negative relation should prevail among financially unconstrained firms.

As it is common in the literature, we use several measures to separate firms based on their financial constraint status. We use excess cash and dividend policy to classify firms as internally financially constrained/unconstrained and debt rating and size-age (SA) index of Hadlock and Pierce (2010) to classify firms as externally financially constrained/unconstrained.

Regarding internal financial constraint status, we estimate excess cash using Fama-McBeth regressions of model 1 of Table 4 in Opler et al. (1999). Then, we use the residuals to estimate the financial constraint status of our sample firms. A firm is classified as financially constrained in year t when the residual value is above the sample median in that year, and unconstrained otherwise. Excess cash with a value greater than the median indicates the availability of cheap internal financing while less than the median excess cash highlights the importance of other costlier financing means (e.g. debt or equity financing).

In addition, we use a firm's dividend policy. Fazzari et al. (1988) argue that unconstrained firms are relatively more likely to have higher dividend payments, while constrained firms are relatively less likely to pay dividends. Therefore, a firm is classified as financially constrained in year t when it does not pay dividends in that year, and unconstrained otherwise (for a similar approach, see also, Denis and Sibilkov (2010)).

²² The issue of reverse causality, or endogeneity more broadly, is very important as both observable and unobservable characteristics could be selection criteria when hiring CEOs. Although we perform several robustness analyses, it is rather hard to identify all of them ex-ante and control for them. Nevertheless, endogeneity does not seem to affect our main conclusions. For instance, if a board chooses an overconfident CEO especially during periods of high stock returns, it should be aware of the potential overinvestment / underinvestment effects that this behavioral bias may cause across the tenure of the CEO, and consider steps to explicitly address them.

Table 11
The Role of Financial Constraint Status.

Panel A: Costly external finance hypothesis	Internally financially constrained		Internally and externally financially constrained	
	(1)	(2)	(3)	(4)
ΔC_t	2.954*** (3.43)	2.957*** (3.42)	0.996 (0.81)	0.924 (0.75)
Overconfident _t	-0.031* (-1.79)		-0.019 (-0.79)	
$\Delta C_t \times$ Overconfident _t	0.347 (1.46)		1.013*** (2.99)	
Low confidence _t		-0.004 (-0.14)		0.043 (1.05)
$\Delta C_t \times$ Low confidence _t		0.344 (0.90)		1.001** (2.46)
High confidence _t		-0.038** (-2.00)		-0.034 (-1.27)
$\Delta C_t \times$ High confidence _t		0.334 (1.27)		0.981*** (2.58)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes
Adjusted R ²	0.226	0.226	0.258	0.258
Observations	3017	3017	1385	1385

Panel B: Overinvestment hypothesis	Internally financially unconstrained		Internally and externally financially unconstrained	
	(1)	(2)	(3)	(4)
ΔC_t	1.743*** (2.59)	1.711** (2.51)	2.911*** (2.88)	2.820*** (2.75)
Overconfident _t	-0.057*** (-3.70)		-0.054*** (-2.67)	
$\Delta C_t \times$ Overconfident _t	-0.050 (-0.23)		-0.563* (-1.67)	
Low confidence _t		-0.080*** (-3.89)		-0.057** (-2.26)
$\Delta C_t \times$ Low confidence _t		0.085 (0.34)		-0.015 (-0.03)
High confidence _t		-0.047*** (-2.70)		-0.053** (-2.35)
$\Delta C_t \times$ High confidence _t		-0.111 (-0.43)		-0.694** (-1.96)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes
Adjusted R ²	0.222	0.222	0.238	0.238
Observations	2824	2824	1466	1466

This table presents coefficient estimates of specifications (2) and (3) of Table 3 after splitting firm-year observations based on their financial constraint status. The dependent variable is the annual excess return of the firm relative to the Fama and French (1993) twenty-five value weighted size and book-to-market portfolios. CEO overconfidence, low and high confidence are based on a longholder measure. Variable definitions are provided in Appendix A. Panel A refers to the costly external finance hypothesis. Panel B refers to the overinvestment hypothesis. Standard errors are adjusted for heteroskedasticity and firm clustering. *T*-statistics are reported within brackets below the corresponding coefficient estimate. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

Based on these measures, we define a firm as being *internally* financially constrained (unconstrained) when both excess cash and dividend payer proxies indicate that the firm is financially constrained (unconstrained).

Concerning external financial constraint status, we focus on the existence of a credit rating that is higher than the investment grade threshold. We classify firms with positive debt outstanding in a given year into the high financially constrained group in that year if the firm has either no credit rating information or its long-term debt is associated with a speculative grade rating in Compustat for that year. Firms with no debt outstanding and firms with investment grade ratings are classified as low financially constrained. Investment grade rating allows firms to access the public debt market at a lower cost. Non-rated firms and firms with speculative grade ratings have less available financing options relative to firms with investment grade ratings. The empirical literature provides ample evidence that rated firms are less constrained than non-rated ones, and higher ratings allow a firm to increase its financing options, such as the access to the commercial paper market (see, e.g., Faulkender and Petersen (2006) and Kising (2007)).

In addition, we use the SA index of Hadlock and Pierce (2010). The authors provide a critical analysis of widely used financial constraint measures. They categorize financial constraints with detailed qualitative information from financial filings and relate their qualitative measure to quantitative factors using order logit regressions. Among the different factors, age and size are particularly useful in predicting financial constraint levels. We use the size-age equation provided by Hadlock and Pierce (2010) to calculate the financial constraint level of our sample firm for each year (see Appendix A for detailed description). A firm is classified as financially constrained in year *t* when the SA index is above the sample median in that year (these are generally smaller and younger firms), and unconstrained otherwise. Beck et al. (2006), using the World Business Environment Survey, illustrate that smaller and younger firms have relatively lower access to external finance.

Based on these measures, we define a firm as being *externally* financially constrained (unconstrained) when both debt rating and SA index proxies indicate that the firm is financially constrained (unconstrained).

Table 11 reports the results by financial constraint status. Panel A tests the underinvestment hypothesis (i.e., we use the subsample of firms that are classified as being financially constrained). When we focus on internal financial constraint status (specifications (1) and (2)), we do not find any relation between CEO overconfidence and the value of cash. Nevertheless, when we

concentrate on both internally and externally financially constrained firms (specifications (3) and (4)), the results show a strong positive relation between CEO overconfidence and the value of cash ($p < .01$ and $p < .01$, respectively). These findings corroborate the costly external finance hypothesis because such firms are more likely to underinvest.

Panel B tests the overinvestment hypothesis (i.e., we use financially unconstrained firms). Among the internally financially unconstrained firms (specifications (1) and (2)) the results show no relation between CEO overconfidence and the value of cash. When further conditioning the sample to externally financially unconstrained firms (specifications (3) and (4)), however, the results show a negative relation between CEO overconfidence and the value of cash ($p < .10$ and $p < .05$, respectively), consistent with the overinvestment hypothesis. Apparently, adding the external financial constraint status increases the power of the analysis, implying that, on average, overconfident CEOs perceive financing costs as lower than the overestimated investment returns, resulting in overinvestment.

4.2. Costly external finance hypothesis and growth opportunities

Although the findings thus far show that additional cash is more valuable among financially constrained firms because it alleviates underinvestment, an interesting question is whether these findings are driven by firms that exhibit certain characteristics. Galasso and Simcoe (2011) argue that overconfident CEOs, who underestimate the probability of failure, are more likely to innovate. In addition, Hirshleifer et al. (2012) find that overconfident CEOs are better in exploiting R&D growth opportunities to create firm value. Therefore, among firms that exhibit R&D growth opportunities, underinvestment should be more painful for shareholders. In addition, if cash alleviates underinvestment problems, then there must be also a more positive relation between CEO overconfidence and the value of cash.

In this section, we test this conjecture using the sub-sample of internally financially constrained firms (specifications (1) and (2) of Table 11).²³ A firm-level measure of R&D growth opportunities complicates the analysis because R&D growth opportunities and cash policy might be endogenously related. Hence, for identification purposes we require an approach that enables the exogenous measurement of R&D growth opportunities. We therefore measure growth opportunities at the industry level using the 48-industry classification developed by Fama and French (1997). In addition, to further alleviate endogeneity concerns, we also consider a lead of one year with respect to the measurement of firm's cash holding in our valuation regressions.

More specifically, in a given year, we consider all firms in the Compustat universe and classify industries into high and low growth opportunities using as a growth measure R&D expenses. A given industry is considered to have high (low) growth opportunities in year t when the aggregate industry R&D expenses in year $t + 1$ to aggregate industry total assets at the beginning of the period is above (below) the median in that year. We scale the industry R&D expenses by the aggregate total assets in order to control for the size of the industry.

Table 12 presents the results. As expected, the positive relation between CEO overconfidence and the value of cash concentrates among financially constrained firms that exhibit high R&D growth opportunities. Depending on the severity of firm's financial constraints and the availability of R&D growth opportunities, having overconfident CEO on board increases the value of \$1.00 cash holding by an additional amount of \$0.74 relative to a firm run by a rational CEO.

5. Conclusion

This study investigates the relation between CEO overconfidence and the value of cash. Overconfident CEOs are commonly known to believe that their firms are undervalued by the market, thus perceiving external financing as unduly costly. As a result, they rely more on internal funds to finance their investment projects. When internal funds, however, are not sufficient, overconfident CEOs may underinvest and additional cash should be valuable since it allows the firm to alleviate its underinvestment problem. Consistent with the costly external finance hypothesis (underinvestment channel), CEO overconfidence affects positively the value of cash holdings. This effect is more pronounced within financially constrained firms and within firms that exhibit high R&D growth opportunities. These firms are more likely to suffer from the underinvestment problem. The results hold to a battery of robustness tests and alternative explanations. Collectively, the results support the view that cash saving is a value-increasing response in firms with overconfident CEOs, as additional cash alleviates the underinvestment problem and allows the firm to further deplete its investment opportunity set.

Our findings have important implications on our understanding of corporate investment policies. Many studies show that investments depend on various frictions that generate financial constraints for firms. We find that the overconfidence nature of CEOs affects the value of cash beyond the effects of traditional financial constraint proxies. This implies that due to high perceived external financing cost, the average overconfident CEO is more financially constrained than the average rational CEO, resulting in underinvestment. Thus, CEO overconfidence is an additional explanation for corporate investment distortions, particularly underinvestment.

In addition, our findings have important implications for corporate governance policies and more specifically on the role of boards in selecting, incentivizing, and monitoring CEOs. Overconfident CEOs, unlike agency-based explanations, unconsciously disregard shareholders' interests since they may underinvest when their firms lack internal resources and exhibit high growth opportunities.

²³ Using the subsample of firms that are both internally and externally financially constrained reduces the sample dramatically which does not allow to draw any useful inferences.

Table 12
Financial Constraint Status and Industry R&D Growth Opportunities.

	Low R&D growth	Low R&D growth	High R&D growth	High R&D growth
	(1)	(2)	(3)	(4)
ΔC_t	1.503 (0.94)	1.410 (0.74)	2.956*** (2.91)	3.016*** (2.97)
Overconfident _t	0.003 (0.14)		-0.051 (-2.20)	
$\Delta C_t \times \text{Overconfident}_t$	-0.074 (-0.19)		0.735*** (2.40)	
Low confidence _t		0.034 (0.74)		-0.022 (-0.68)
$\Delta C_t \times \text{Low confidence}_t$		0.116 (0.16)		0.581 (1.18)
High confidence _t		-0.004 (-0.16)		-0.060** (-2.22)
$\Delta C_t \times \text{High confidence}_t$		-0.157 (-0.37)		0.767** (2.22)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Control variables	Yes	Yes	Yes	Yes
Adjusted R ²	0.276	0.276	0.217	0.217
Observations	1331	1331	1686	1686

This table uses the subsample of internally financially constrained firms and presents coefficient estimates of Panel A of Table 11 after splitting firm-year observations based on industry R&D growth opportunities. Specifications (1) and (2) refer to firms with low industry R&D growth opportunities whereas specifications (3) and (4) refer to firms with high industry R&D growth opportunities. The dependent variable is the annual excess return of the firm relative to the Fama and French (1993) twenty-five value weighted size and book-to-market portfolios. CEO overconfidence, low and high confidence are based on a longholder measure. Variable definitions are in Appendix A. Standard errors are adjusted for heteroskedasticity and firm clustering. *T*-statistics are reported within brackets below the corresponding coefficient estimate. ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively.

Therefore, traditional equity-based-compensation is unlikely to affect their decision making and alleviate underinvestment. As a result, when selecting an overconfident CEO, effective boards, for instance, (i) may take measures to improve active monitoring of a firm's internal resources policy and (ii) appoint (rational) directors with financial expertise (e.g. bankers) that may facilitate external financing when the firm is financially constrained.

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Appendix A. Variable definitions

All names within square brackets refer to Compustat item names. All dollar values are adjusted to 2013 dollars by the consumer price index.

Dependent Variable

Excess return_t: Buy-and-hold excess stock return over the calendar year defined as $\Pi(1 + R_{i,m}) - \Pi(1 + R_{p,m})$, where $R_{i,m}$ and $R_{p,m}$ are the return for firm *i* and the return of the benchmark portfolio for month *m* in year *t*. Benchmark portfolios are the twenty-five Fama-French value-weighted portfolios based on size and book-to-market.

Independent Variables

ΔC_t : Change in cash holdings [CHE] in year *t* (i.e., $CHE_t - CHE_{t-1}$), scaled by market value of equity [PRCC x CSHO] in year *t*-1.

Overconfident_t: Longholder measure of CEO overconfidence. Indicator variable that equals 1 during the tenure of a CEO when at least once during the period 2006–2013, holds an option until the year of expiration, even though the stock option is at least 40% in-the-money entering its final year, and 0 otherwise. CEOs that never exercise options do not reveal beliefs and, thus, longholder is set to missing.

Low Confidence_t: Based on longholder measure of CEO overconfidence. Indicator variable that equals 1 during the tenure of a CEO when at least once during the period 2006–2013, holds an option until the year of expiration, and the stock option is below 66.22% in-the-money entering its final year, and 0 otherwise. The threshold of 66.22% is the 25th percentile in-the-money option value of the sample. CEOs that never exercise options do not reveal beliefs and, thus, low confidence is set to missing.

High Confidence_t: Based on longholder measure of CEO overconfidence. Indicator variable that equals 1 during the tenure of a CEO when at least once during the period 2006–2013, holds an option until the year of expiration, and the stock option is greater or equal to 66.22% in-the-money entering its final year, and 0 otherwise. The threshold of 66.22% is the 25th percentile in-the-money option value of the sample. CEOs that never exercise options do not reveal beliefs and, thus, high confidence is set to missing.

Overconfident (Press)_t: Press-based measure of CEO overconfidence. Indicator variable that equals 1 when the number of

“confident” articles for a CEO in Factiva is greater than the number of “cautious” articles, and 0 otherwise.

Overconfident (Gender)_t: Gender-based measure of executive overconfidence. Indicator variable that equals 1 when the CEO or the CFO of the firm is male. We identify gender, CEO and CFO using ExecuComp's classification (data item GENDER = MALE; CEOANN = CEO; and TITLEANN contains any of the following words: CFO, chief financial officer, treasurer, controller, finance, and vice-president finance, respectively).

ΔE_t : Change in earnings in year t , scaled by market value of equity in year $t-1$. Earnings are calculated as earnings before extraordinary items [IB] plus interest [XINT], deferred tax credits [TXDI], and investment tax credits [ITCI].

ΔNA_t : Change in net assets in year t , scaled by market value of equity in year $t-1$. Net assets is total assets [AT] minus cash holdings [CHE].

ΔRD_t : Change in research and development expenses [XRD] in year t , scaled by market value of equity in year $t-1$.

ΔI_t : Change in interest expenses [XINT] in year t , scaled by market value of equity in year $t-1$.

ΔD_t : Change in dividends [DVC] in year t , scaled by market value of equity in year $t-1$.

C_{t-1} : Lagged cash holdings, scaled by market value of equity in year $t-1$.

L_t : Market leverage in year t calculated as the ratio of total debt to market value of the firm. Total debt is the sum of long-term debt [DLTT] and debt in current liabilities [DLC]. Market value of the firm is calculated as total debt plus market value of equity.

NF_t : Net financing in year t calculated as total equity issuance [SSTK] minus repurchases [PRSTKC] plus debt issuance [DLTIS] minus debt redemption [DLTR].

CEO age: The age of the CEO as reported in ExecuComp.

Vega/TC: The change in the dollar value of the CEO wealth for a one percentage change in the annualized standard deviation of stock returns at the end of the fiscal year, scaled by the CEO's total compensation.

Delta/TC: The change in the dollar value of the CEO wealth for a one percentage point change in stock price at the end of the fiscal year, scaled by the CEO's total compensation.

Measures of Internal Financial Constraint Status

Excess cash: A firm is classified as highly financially constrained in year t when the residual of the Opler et al. (1999) corporate cash model 1 of Table 4 is above the sample median in that year, and low financially constrained otherwise.

Dividend payers: A firm is classified as highly financially constrained in year t when it does not pay dividends in that year [DVC], and low financially constrained otherwise.

Measures of External Financial Constraint Status

Debt rating: A given firm with debt outstanding is classified as highly financially constrained in year t when either it is unrated or its debt has a non-investment grade rating. Firms with no debt outstanding and with investment grade ratings are classified in the low financially constraint group.

SA index: The size-age index of Hadlock and Pierce (2010) computed using the following equation: $-0.737 \text{ Size} + 0.043 \text{ Size}^2 - 0.040 \text{ Age}$, where *Size* is the log of inflation adjusted (to 2004) book assets, and *Age* is the number of years the firm has been on Compustat with a non-missing stock price. *Size* is replaced with log (\$4.5 billion) and *Age* with 37 years if the actual values exceed these thresholds. A firm is classified as highly financially constrained in year t when the SA index is above the sample median in that year, and low financially constrained otherwise.

Measure of R&D Growth Opportunities

Industry R&D expenses: A given Fama-French 48-industry has high (low) growth opportunities in year t when the aggregate industry R&D expenses [XRD] in year $t + 1$ to aggregate industry total assets at the beginning of the period is above (below) the sample median in that year. The estimation is based on all Compustat firms before applying sample restrictions.

Appendix B. Value of cash – Compustat versus ExecuComp sample

This table reports OLS regressions to estimate the value of cash based on specification (2) in Table II of Faulkender and Wang (2006). To be included in the sample, firms are required to belong in the S&P 1500 index with available observations in the ExecuComp, CRSP, and Compustat databases. In addition, we exclude firm-years with market value of equity < 25 million in constant 2013 dollars, negative sales, negative net assets, negative dividends, negative capital expenditures and firms from the financial (SIC 6000-6999) and utility (SIC 4900-4999) industries. The dependent variable is the annual excess return of the firm relative to the Fama and French (1993) twenty-five value weighted size and book-to-market portfolios. Δ indicates the change from the previous year. C_t is cash holding, E_t is earnings before interest and extraordinary items, NA_t is total assets minus cash holdings, RD_t is research and development expenses, I_t is interest expenses, D_t is common dividends, L_t is market leverage, and NF_t is net financing. Variable definitions are in Appendix A. Panel A reports estimates using the period (1) 1972–2001 (i.e., sample period in Faulkender and Wang 2006); (2) 1993–2013 using Compustat data; (3) 1993–2013 using ExecuComp data, and (4) 1993–2013 using ExecuComp data with non-missing information about CEO overconfidence. Panel B uses the mean (in-sample for each regression) levels of C_{t-1} and L_t , to compute the marginal value of \$1 in cash for the average firm for the above four different samples.

Panel A. OLS Regressions

	(1) Compustat sample period: 1972–2001		(2) Compustat sample period: 1993–2013		(3) ExecuComp sample period: 1993–2013		(4) ExecuComp & CEO overconfidence sample period: 1993–2013	
	Coef.	t-stat	Coef.	Coef.	t-stat	t-stat	Coef.	t-stat
ΔC_t	1.230***	34.36	1.576***	34.73	1.703***	27.24	1.638***	19.77
ΔE_t	0.696***	37.74	0.564***	28.97	0.466***	16.87	0.466***	13.42
ΔNA_t	0.104***	12.92	0.178***	16.55	0.214***	14.65	0.201***	10.36
ΔRD_t	0.333**	2.15	-0.007	-0.04	0.317	1.15	0.517	1.28
ΔI_t	-1.924***	-19.22	-2.453***	-13.62	-2.594***	-8.31	-2.527***	-5.20
ΔD_t	2.464***	11.77	0.991***	4.05	0.443	1.38	0.161	0.43
C_{t-1}	0.341***	23.72	0.295***	19.44	0.299***	13.74	0.247***	9.26
L_t	-0.309***	-35.47	-0.311***	-30.13	-0.351***	-24.05	-0.314***	-16.97
NF_t	0.048***	3.42	-0.073	-3.69	-0.149***	-4.90	-0.151**	-3.77
$\Delta C_t \times C_{t-1}$	-0.559***	-8.43	-0.907***	-10.73	-0.718***	-5.14	-0.822***	-4.44
$\Delta C_t \times L_t$	-1.057***	-14.64	-1.035***	-10.71	-1.465***	-9.28	-1.199***	-5.64
Intercept	0.038***	12.12	0.016***	4.38	0.037***	8.57	0.062***	10.91
Adjusted R ²	0.142		0.138		0.160		0.157	
Observations	67,887		51,776		22,667		12,105	

Panel B. The marginal value of cash for the average firms

Sample means					
C_{t-1}	0.142		0.151	0.124	0.132
L_t	0.249		0.186	0.188	0.178
Value of \$1	0.89		1.25	1.34	1.32

References

- Acharya, V., Davydenko, S.A., Strebulaev, I.A., 2012. Cash holdings and credit risk. *Rev. Financ. Stud.* 25, 3572–3609.
- Banerjee, S., Humphery-Jenner, M., Masulis, R., Nanda, V., Xu, L., 2015. Why Do Overconfident CEOs Issue Equity? Working Paper. University of Wyoming, UNSW Business School, Rutgers Business School, and Nanyang Business School.
- Barber, B., Odean, T., 2001. Boys will be boys: Gender, overconfidence, and common stock investment. *Q. J. Econ.* 116, 261–292.
- Bates, T.W., Chang, C., Chi, J.D., 2018. Why has the value of cash increased over time? *J. Financ. Quant. Anal.* 53, 749–787.
- Bebchuk, L.A., Cohen, A., Ferrell, A., 2009. What matters in corporate governance? *Rev. Financ. Stud.* 22, 783–827.
- Beck, T., Demirguc-Kunt, A., Laeven, L., Maksimovic, V., 2006. The determinants of financing obstacles. *J. Int. Money Financ.* 25, 932–952.
- Bernardo, A.E., Welch, I., 2001. On the evolution of overconfidence and entrepreneurs. *J. Econ. Manag. Strateg.* 10, 301–330.
- Bertrand, M., Schoar, A., 2003. Managing with style: the effect of managers on firm policies. *Q. J. Econ.* 118, 1169–1208.
- Bharath, S.T., Shumway, T., 2008. Forecasting default with the Merton distance to default model. *Rev. Financ. Stud.* 21, 1339–1369.
- Bushee, B., 1998. The influence of institutional investors on myopic R&D investment behavior. *Account. Rev.* 73, 305–333.
- Campbell, T.C., Gallmeyer, M., Johnson, S.A., Rutherford, J., Stanley, B.W., 2011. CEO optimism and forced turnover. *J. Financ. Econ.* 101, 695–712.
- Chen, T., Harford, J., Lin, C., 2017. Financial Flexibility and Corporate Cash Policy. Working Paper. University of Washington.
- Dahya, J., McConnell, J.J., Travlos, N.G., 2002. The Cadbury committee, corporate performance, and top management turnover. *J. Financ.* 57, 461–483.
- Daniel, K., Titman, S., 1997. Evidence on the characteristics of cross sectional variation in stock returns. *J. Financ.* 52, 1–33.
- Demerjian, P., Lev, B., McVay, S., 2012. Quantifying managerial ability: a new measure and validity tests. *Manag. Sci.* 58, 1229–1248.
- Denis, D.J., Sibilkov, V., 2010. Financial constraints, investment, and the value of cash holdings. *Rev. Financ. Stud.* 23, 247–269.
- Deshmukh, S., Goel, A.M., Howe, K.M., 2013. CEO overconfidence and dividend policy. *J. Financ. Intermed.* 22, 440–463.
- Deshmukh, S., Goel, A.M., Howe, K.M., 2016. Do CEO Beliefs Affect Corporate Cash Holdings? Working Paper. DePaul University and Navigant Consulting.
- Dittmar, A.K., Mahr-Smith, J., 2007. Corporate governance and the value of cash holdings. *J. Financ. Econ.* 83, 599–634.
- Drucker, S., Puri, M., 2005. On the benefits of concurrent lending and underwriting. *J. Financ.* 60, 2763–2799.
- Falato, A., Li, D., Milbourn, T., 2015. Which skills matter in the market for CEOs? Evidence from pay for CEO credentials. *Manag. Sci.* 61, 2845–2869.
- Fama, E.F., French, K.R., 1993. Common risk factors in the returns on stocks and bonds. *J. Financ. Econ.* 33, 3–56.
- Fama, E.F., French, K.R., 1997. Industry costs of equity. *J. Financ. Econ.* 43, 153–193.
- Faulkender, M., Petersen, M.A., 2006. Does the source of capital affect capital structure? *Rev. Financ. Stud.* 19, 45–79.
- Faulkender, M., Wang, R., 2006. Corporate financial policy and the value of cash. *J. Financ.* 61, 1957–1990.
- Fazzari, S., Hubbard, R.G., Petersen, B.C., 1988. Financing constraints and corporate investment. In: *Brookings Papers on Economic Activity*. 1. pp. 141–195.
- Frésard, L., Salva, C., 2010. The value of excess cash and corporate governance: evidence from US cross-listings. *J. Financ. Econ.* 98, 359–384.
- Galasso, A., Simcoe, T., 2011. CEO overconfidence and innovation. *Manag. Sci.* 57, 1469–1484.
- Gervais, S., Heaton, J.B., Odean, T., 2011. Overconfidence, compensation contracts, and capital budgeting. *J. Financ.* 66, 1735–1777.
- Goel, A., Thakor, A., 2008. Overconfidence, CEO selection, and corporate governance. *J. Financ.* 63, 2737–2784.
- Hadlock, C.J., Pierce, J.R., 2010. New evidence on measuring financial constraints: moving beyond the KZ index. *Rev. Financ. Stud.* 23, 1909–1940.
- Halford, J.T., McConnell, J.J., Sibilkov, V., Zaiats, N., 2017. Cash Regimes and the Marginal Value of Cash. Working Paper. Purdue University.
- Hall, B., Murphy, K., 2002. Stock options for undiversified executives. *J. Account. Econ.* 33, 3–42.
- Harford, J., Klasa, S., Maxwell, W.F., 2014. Refinancing risk and cash holdings. *J. Financ.* 69, 975–1012.
- Heaton, J.B., 2002. Managerial optimism and corporate finance. *Financ. Manag.* 31, 33–45.
- Hirshleifer, D., Low, A., Teoh, S.H., 2012. Are overconfident CEOs better innovators? *J. Financ.* 67, 1457–1498.

- Hribar, P., Yang, H., 2015. CEO overconfidence and management forecasting. *Contemp. Account. Res.* 33, 204–227.
- Huang, J., Kisgen, D.J., 2013. Gender and corporate finance: are male executives overconfident relative to female executives? *J. Financ. Econ.* 108, 822–839.
- Jensen, M.C., Meckling, W.H., 1976. Theory of the firm: managerial behavior, agency costs and ownership structure. *J. Financ. Econ.* 3, 305–360.
- Kalcheva, I., Lins, K.V., 2007. International evidence on cash holdings and expected managerial agency problems. *Rev. Financ. Stud.* 20, 1087–1112.
- Kaplan, S.N., Minton, B.A., 2011. How has CEO turnover changed? *Int. Rev. Financ.* 12, 57–87.
- Kisgen, D.J., 2007. The influence of credit ratings on corporate capital structure decisions. *J. Appl. Corp. Financ.* 19, 65–73.
- Liu, Y., Mauer, D.C., 2011. Corporate cash holdings and CEO compensation incentives. *J. Financ. Econ.* 102, 183–198.
- Malmendier, U., Tate, G., 2005. CEO overconfidence and corporate investment. *J. Financ.* 60, 2661–2700.
- Malmendier, U., Tate, G., 2008. Who makes acquisitions? CEO overconfidence and the market's reaction. *J. Financ. Econ.* 89, 20–43.
- Malmendier, U., Tate, G., 2015. Behavioral CEOs: on the role of managerial overconfidence. *J. Econ. Perspect.* 29, 37–60.
- Malmendier, U., Tate, G., Yan, J., 2011. Overconfidence and early-life experiences: the effect of managerial traits on corporate financial policies. *J. Financ.* 66, 1687–1733.
- Merton, R.C., 1974. On the pricing of corporate debt: the risk structure of interest rates. *J. Financ.* 29, 449–470.
- Myers, S.C., Majluf, N.S., 1984. Corporate financing and investment decisions when firms have information that investors do not have. *J. Financ. Econ.* 13, 187–221.
- Opler, T., Pinkowitz, L., Stulz, R., Williamson, R., 1999. The determinants and implications of corporate cash holdings. *J. Financ. Econ.* 52, 3–46.
- Phua, J.K., Tham, T.M., Wei, C., 2018. Are overconfident CEOs better leaders? Evidence from stakeholder commitments. *J. Financ. Econ.* 127, 519–545.
- Pinkowitz, L., Stulz, R., Williamson, R., 2006. Does the contribution of corporate cash holdings and dividends to firm value depend on governance? A cross-country analysis. *J. Financ.* 61, 2725–2753.
- Roll, R., 1986. The hubris hypothesis of corporate takeovers. *J. Bus.* 59, 197–216.