

CEO Overconfidence and the Speed of Adjustment of Cash Holdings

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Abstract

In this study, we examine the links between CEO overconfidence, the speed of adjustment (SOA) of cash holdings, and firm value for listed US firms, finding a positive effect of CEO overconfidence on SOA. We address endogeneity concerns using a difference-in-differences approach, propensity score matching, and entropy balancing. Our results are robust to the use of alternative estimation methods. Finally, we conclude that financial constraints, leverage, and corporate governance quality affect the relation between CEO overconfidence and the SOA of cash holdings.

Keywords: cash holdings, speed of adjustment, CEO overconfidence, corporate governance, financial constraints, leverage

JEL Classifications: G32, G34

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Abstract

In this study, we examine the links between CEO overconfidence, the speed of adjustment (SOA) of cash holdings, and firm value for listed US firms, finding a positive effect of CEO overconfidence on SOA. We address endogeneity concerns using a difference-in-differences approach, propensity score matching, and entropy balancing. Our results are robust to the use of alternative estimation methods. Finally, we conclude that financial constraints, leverage, and corporate governance quality affect the relation between CEO overconfidence and the SOA of cash holdings.

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1. Introduction

This paper investigates whether—and if so, how—CEO overconfidence affects the speed of adjustment (SOA) of cash holdings for listed nonfinancial US firms during the period between 1996 and 2020. While extant literature has studied the effects of overconfident CEOs on cash holdings *levels* and their values, it has neglected the effects of such CEOs on SOA. Why would the SOA of cash holdings matter? Graham and Harvey's (2001) survey reveals that, when US chief financial officers make financial decisions, they have in mind not only targets, including a target level of cash holdings, but also the SOA at which they move toward their targets. Importantly, Bates et al.'s (2018) study suggests that a faster SOA is beneficial, as it is associated with a lower cost of financing and higher firm value. Similarly, we argue that SOA matters because it is value-relevant above and beyond the level of cash holdings. Importantly, our results reveal that firms have a faster SOA when they are managed by overconfident managers. In comparison, non-overconfident CEOs take an additional eight to nine months compared with overconfident CEOs to adjust their cash holdings toward their optimal level.

In terms of cash holdings levels, capital market imperfections create an association between the cash holdings level and firm value (Gao et al., 2013). This association includes an optimal cash holdings level that maximizes firm value. Indeed, as Opler et al. (1999) show, managers do not let cash holdings rise significantly above or drop significantly below the optimal level, which implies a fast SOA and a rapid return to the optimal cash balance. Still, cross-sectional studies assume that firms operate close to their optimal levels; hence, the observed cash holdings level for a firm at any time should not be significantly different from its optimal level (Foley et al., 2007; Bates et al., 2009). In other words, these studies assume that, when firms deviate from their optimal level or the optimal level changes, they move to their optimal level virtually instantaneously.

Why would there be a target cash holdings level? Two reasons for this may be identified. First, Guariglia and Yang (2018) review the theoretical explanations for the existence of such a

target level and find that, according to the trade-off theory, firms optimally weigh the costs and benefits of holding a specific level of cash holdings to reduce their risk and increase their value. Second, Jensen (1986) develops a free cash flow hypothesis focusing on conflicts of interest between shareholders (i.e., the principals) and managers (i.e., the agents), and this hypothesis suggests that such conflicts may lead to agency costs. Because managers may squander corporate cash for their personal benefit, there is an optimal cash holdings level that minimizes the agency costs between the shareholders and the managers.¹

Although theory predicts the existence of optimal cash holdings levels, empirical research suggests various factors that reduce the speed at which firms move toward their optimal level (Dittmar and Duchin, 2010). These factors include external factors, such as capital market frictions (Bates et al., 2018) and macroeconomic shocks; they also include internal factors, such as financial constraints and agency conflicts (Gao et al., 2013). More specifically, when there is asymmetric information, firms that are subject to financial constraints may hoard more cash and deviate significantly from their optimal cash holdings level (Harford, 1999; Opler et al., 1999; Byoun, 2008; Faulkender et al., 2012; Chung et al., 2015; Harris and Raviv, 2017). Agency conflicts are an additional internal factor explaining differences in the SOA toward the optimal cash holdings level across firms: The SOA is likely to be slower for firms suffering from such conflicts. Jiang and Lie (2016) confirm that entrenched managers go hand in hand with a slower SOA of cash holdings.²

While the studies described above assume that CEOs are rational, a growing body of literature acknowledges that there are biases in managerial behavior and that these biases affect corporate decision-making, including decisions about investments (Malmendier and Tate, 2005), financing

¹ While Myers and Majluf's (1984) pecking order theory predicts that firms that need additional financing for their investment activities avoid external financing and instead use accumulated internal cash, this theory does not imply the existence of target cash levels.

² Nikolov and Whited (2014) find that agency problems, on average, lead to cash holdings exceeding their optimal level, resulting in lower firm value. Similarly, the CEO's desire for a quiet life leads to a higher than optimal cash holdings level (Bertrand and Mullainathan, 2003). Finally, Jiang and Lie (2016) find that entrenched managers keep cash holdings at a higher level than the optimal level.

(Malmendier et al., 2011), mergers and acquisitions (Malmendier and Tate, 2008), research and development (R&D) and innovation (Hirshleifer et al., 2012), and importantly, cash holdings policies (Chen et al., 2020). Managerial overconfidence should then be highly relevant for cash holdings, as it might affect the CEO's perceptions about the optimal cash holdings level and the adjustment costs toward this level. To the best of our knowledge, this is the first study to examine whether CEO overconfidence affects the SOA of cash holdings.

In the absence of shocks, such as economic crises, and frictions in the capital markets, a firm's cash holdings should be at their optimal level, or at the very least, if they have been pushed away from the optimal level, they should revert to it virtually instantaneously. This would imply a very high SOA as per the static version of the trade-off theory of cash holdings.³ However, given the existence of frictions and adjustment costs, the SOA is likely to be less than instantaneous, as predicted by the dynamic version of the trade-off theory of cash holdings.

Importantly, SOA has the potential to be value-relevant: A slow SOA coupled with cash holdings below the optimal level may force the firm to forgo valuable projects. In addition, a slow SOA combined with cash holdings that exceed their optimal level may cause investors to be concerned about management potentially mispending the cash on empire building, including value-destroying acquisitions and other negative net present value projects. In both cases, managers should be motivated to adopt a high SOA to maximize the value of their firm. In support of this argument, the findings of Harford et al. (2008) and Faulkender and Wang (2006) imply that deviations from the optimal cash holdings level because of a relatively slow SOA reduce the value of a firm.

Why would CEO overconfidence affect the SOA of cash holdings? We argue that CEO overconfidence increases the SOA. Similar to Deshmukh et al. (2021), we expect overconfident

³ Using trade-off theory, Do et al. (2022) find empirical evidence of the value relevance of the SOA of leverage for US firms, noting that decisions about cash holdings and leverage are related. Indeed, being as close as possible to the target cash holdings level is associated with reduced risk and a lower cost of borrowing, which is in turn associated with a higher firm value (see, e.g., Gao et al., 2013; Bates et al., 2018).

CEOs to perceive their firms' equity to be underpriced. Hence, such CEOs will rely more heavily on internal cash to finance their current investments and delay raising external financing, which results in a higher SOA. This is our first testable hypothesis.

Our study also considers two competing hypotheses on how overconfident managers affect SOA in the presence of excess corporate cash holdings. On the one hand, SOA and CEO overconfidence may be positively related, because overconfident managers dissipate excess cash quickly. On the other, SOA and CEO overconfidence may be negatively related because CEO overconfidence is associated with cash savings when external borrowing is perceived as prohibitively costly.

First, we find that, overall, the SOA is faster for firms with overconfident CEOs, whereas it is slower for non-overconfident CEOs. Thus, we find that the association between overconfidence and SOA is positive. Specifically, it takes about eight to nine months longer for firms with non-overconfident CEOs to adjust their cash holdings to their optimal level relative to firms with overconfident CEOs. Second, we find empirical evidence to suggest that overconfident managers quickly dissipate excess cash, leading to a higher SOA. Therefore, our results do not lend support to the cash savings view.

To overcome potential endogeneity issues, we proceed as follows: First, we use the 2012 US–Korea Free Trade Agreement (KORUS FTA) as a source of exogenous variation in firms' competitive environments. The resulting difference-in-differences (DiD) estimations support the causal impact of CEO overconfidence on the SOA of cash holdings. Second, our main results could still be biased because they might pick up nonlinear effects of the control variables on the SOA of cash holdings. Therefore, we use propensity score matching (PSM) and entropy balancing (EB). We are able to confirm our main findings, and our key results are upheld.

In further analyses, we investigate whether financial constraints, differences in debt levels and credit risk, and the quality of corporate governance affect the relationship between CEO overconfidence and the SOA of cash holdings. We find that the positive impact of CEO

overconfidence on SOA is more pronounced for financially constrained firms. In addition, when we divide our sample into two subsamples, we find that firms with leverage below the sample median tend to have a slower SOA of cash holdings. Further, we control for the quality of corporate governance. We find that this matters, in that the positive effect of CEO overconfidence on SOA is more pronounced for firms with better governance quality. Finally, to check the robustness of our results, we reestimate the optimal cash holdings level for each firm using alternative estimation methods—that is, the first differenced generalized method of moments (GMM), the system GMM, and the Driscoll–Kraay specification. These robustness tests all confirm our main findings.

Our paper provides strong evidence that managerial overconfidence increases the SOA of cash holdings. By doing so, it contributes to two streams of the literature. First, it contributes to the literature that investigates the SOA toward the optimal cash holdings level. Although several factors have already been identified to impact the SOA of cash holdings, our finding that CEO overconfidence increases SOA is novel.

Second, our paper adds to the literature on behavioral finance. A growing body of this literature examines the effects of biases in managerial behavior, such as overconfidence, on corporate decisions (Malmendier and Tate, 2005; Malmendier and Tate, 2008; Hirshleifer et al., 2012). Specifically, we complement two recent studies on the effects of CEO overconfidence on the level (Chen et al., 2020) and value (Aktas et al., 2019) of cash holdings by analyzing the impact of CEO overconfidence on the SOA of cash holdings. While both studies investigate the impact of managerial overconfidence on cash holdings levels and value from a static perspective, we adopt a dynamic perspective by focusing on the speed at which firms close the gap between their actual and optimal cash ratios while controlling for CEO overconfidence. Again, we find that speed matters above and beyond the cash holdings levels.

The paper proceeds as follows: The next section reviews the literature, and Section 3 develops the hypotheses. Section 4 discusses the data sources, the sample construction, and the

methodology. This is followed a description of the summary statistics and the empirical findings in Section 5. Section 6 focuses on the identification strategy. Section 7 describes the robustness checks, while Section 8 conducts additional analyses. Finally, Section 9 concludes the paper.

2. Literature Review

2.1. SOA of cash holdings

Research on the determinants of cash holdings has focused on the cross-sectional dispersion of cash holdings (e.g., Kim et al., 1998; Opler et al., 1999). However, more recently, there has been criticism of the static approach adopted by various studies on the determinants of cash holdings. Indeed, such studies tend to ignore investment and financing frictions, which affect the SOA toward the optimal cash holdings level. Therefore, various papers (e.g., Ozkan and Ozkan, 2004; Flannery and Rangan, 2006; Jiang and Lie, 2016; Guariglia and Yang, 2018) have proposed the use of dynamic models of cash holdings, such as partial adjustment models, which allow for the possibility that firms adjust their cash holdings levels gradually over time.

A related body of literature—that is, the literature on the SOA of leverage⁴—has identified several factors that affect the SOA of leverage toward the target level. These include issuance costs (Altinkilic and Hansen, 2000), the cost of equity (Zhou et al., 2016), equity overvaluation (Flannery and Rangan, 2006; Warr et al., 2012), the availability of credit lines (Lockhart, 2014), debt covenants (Devos et al., 2017), and managerial traits (Lin et al., 2018).

Unlike the extensive body of literature investigating the SOA of leverage, the equivalent literature on cash holdings is still limited. For example, Opler et al. (1999) find evidence in line with the trade-off theory. They report that, when a firm's cash holdings level deviates from its optimal level, the SOA amounts to 26% of the deviation from the optimal level each year. Dittmar and Duchin (2010) also find that, because of the presence of costs, firms do not adjust

⁴ See, e.g., Leary and Roberts (2005), Korajczyk and Levy (2003), Huang and Ritter (2009), and DeAngelo and Roll (2015).

immediately toward their optimal cash level, with the SOA ranging from 22% to 43% depending on the estimation method they use. They also find that SOA is affected by a firm's age and governance mechanisms. In another study, Jiang and Lie (2016) report an SOA of 31%. Although they also study the factors affecting the SOA, their focus is on managerial self-interest and entrenchment. They find that self-interested managers are less willing to distribute excess cash in a timely manner, and this reduces the SOA of cash holdings. Finally, Bates et al. (2018) highlight that market frictions play a role in slowing down the speed at which firms adjust their cash holdings.⁵ To conclude, the SOA from the actual cash holdings level toward the target cash holdings level is not immediate; rather, it is affected by various external and internal frictions.

2.2. CEO overconfidence and SOA

A growing body of literature has attempted to explain the effects of managerial traits, including managerial overconfidence, on cash holdings decisions (Hirshleifer et al., 2012; Deshmukh et al., 2021; El Kalak and Tosun, 2022). For example, Cho et al. (2018) show that greater managerial ability—that is, greater efficiency in generating revenues—affects the SOA of cash holdings for Korean firms. These researchers find that, when the cash holdings exceed their target level, managers with greater ability are more likely to dissipate excess cash compared with managers with less ability.

Turning to overconfidence, the latter is a form of self-attribution bias (Doukas and Petmezas, 2007) that leads overconfident managers to believe they have superior decision-making skills. Managerial overconfidence has been the subject of detailed analysis. For example, Deshmukh et al. (2021) find that firms with overconfident CEOs hold, on average, 24% less cash. In addition, Heaton (2002) proposes a pecking order of sources of finance for overconfident managers. He argues that, since overconfident managers overestimate their firm's future cash flows, they tend to prefer internal to external financing, especially equity. This is because of their perception that

⁵ Relatedly, Chang et al. (2017) show that firms have an optimal range of cash holdings rather than an optimal ratio, within which they are likely to move. Importantly, when firms exit this target zone the SOA accelerates.

their firm's stock is undervalued by the market. Malmendier et al. (2011) provide support for this argument, finding that overconfident managers issue less equity than their peers do. As a consequence, overconfident managers may underinvest if their firm's internal funds are scarce or access to debt is limited. Finally, Aktas et al. (2019) provide further support for this argument. They show that overconfident CEOs increase the value of a one-dollar cash holding by 28 cents. This suggests that additional cash mitigates the underinvestment problem associated with overconfident CEOs.

3. Hypothesis Development

3.1. CEO overconfidence and the SOA of cash holdings

If managers and investors share the same set of beliefs, they should also agree on what constitutes the optimal cash holdings level. Hence, the SOA toward the target cash holdings level should be relatively fast. However, if the sets of beliefs differ, the CEO may have a different view of what constitutes the optimal cash holdings level, reflecting differences in the expected cost of future external financing (Deshmukh et al., 2021). This would be the case if the CEO were suffering from overconfidence.

More precisely, in the absence of divergent views between shareholders and the CEO, we expect overconfident CEOs to increase SOA. Since such CEOs perceive their firm's equity to be underpriced, they delay raising external financing; thus, they rely more heavily on internal cash. As a result, CEO overconfidence affects the speed at which a firm adjusts its cash holdings, and firms with overconfident CEOs have a greater SOA. Therefore, our first hypothesis is as follows:

H1. *CEO overconfidence is positively associated with SOA.*

Despite this association, there may still be differences in SOA among firms with overconfident CEOs. Such differences might be observed for firms with cash holdings exceeding their optimal level. This is discussed in Section 3.2.

3.2. Excess cash, CEO overconfidence, and the SOA of cash holdings

We consider two competing hypotheses for firms holding cash balances exceeding the optimum level. We argue that the SOA among firms with overconfident CEOs may be affected differently for firms with above-optimal cash levels.

On the one hand, according to pecking order theory, asymmetric information and the resulting adverse selection costs are the main determinants of firms' financing decisions (Myers and Majluf, 1984). These costs are associated with a greater preference for internal financing (i.e., cash). The SOA of cash holdings should then be faster if the actual cash holdings level is above the optimal level, as it is cheaper and quicker to use cash than it is to generate it (Jiang and Lie, 2016; Chang et al., 2017; Guariglia and Yang, 2018). More specifically, when the firm has excess cash, overconfident CEOs are willing to invest more cash (Aktas et al., 2019). This argument is supported by Malmendier and Tate (2005), who report greater capital expenditures and merger and acquisition activity for overconfident CEOs of cash-rich firms.⁶ Therefore, we expect that overconfident managers increase their cash spending—that is, dissipate excess cash more quickly—thereby accelerating the SOA toward the firm's optimal cash level when the firm has excess cash. Based on these arguments, we hypothesize the following:

H2A. *CEO overconfidence is positively associated with SOA when the actual cash holdings are above their optimal level.*

On the other hand, Chen et al. (2020) show that firms with overconfident CEOs maintain larger cash holdings than do those with non-overconfident CEOs. Indeed, Deshmuk et al.'s (2013) theoretical model predicts that overconfident managers consider external borrowing to be expensive, that they reduce cash dividends payment, and that they then accumulate cash to finance future investments. Put differently, given overconfident CEOs' belief that investors

⁶ See also Opler et al. (1999); they find that managers tend to hold higher levels of cash if they are risk averse or if they pursue personal objectives.

undervalue their firm, they prefer not to rely on external financing for the financing of their investments; therefore, they hoard cash. Once these firms have excess cash, they are likely to suffer from a lower SOA compared with the SOA of firms managed by non-overconfident CEOs. This discussion leads us to the following competing hypothesis:

H2B. *CEO overconfidence is negatively associated with SOA when the actual cash holdings are above their optimal level.*

4. Data and Methodology

4.1. Sample selection

Our initial sample of firms is drawn from Compustat, and it is based on all US firms with available data listed on the following stock exchanges: AMEX, NYSE, and NASDAQ. To avoid survivorship bias, we include both active and inactive firms. Following the literature, we eliminate observations for financial firms (Standard Industry Codes (SIC) 6000-6999) and regulated utilities (SIC codes 4900-4999). Further, we restrict our sample to firms with US headquarters. We drop observations for which total liabilities are greater than total assets and for which the sum of long-term and short-term debt is greater than total assets. We use the CRSPdatabase for data on stock returns, and IRRC/RiskMetrics and ExecuComp for data on director characteristics, managerial overconfidence, and CEO characteristics. The CEO overconfidence measure we use is based on Campbell et al.'s (2011) modified version of the Malmendier and Tate (2005) measure. Hence, we require CEO options data for all firms. Our final sample consists of 17,478 firm-year observations across 1,478 firms in the period between 1996 (i.e., the first year, with data available from IRRC/Risk Metrics) and 2020. All nonbinary variables are winsorized at the 1st and 99th percentiles to reduce the potential effects of outliers.

4.2. CEO overconfidence measure

A substantial part of the CEO compensation package is in the form of stocks and options. In addition, CEOs have their human capital invested in the firm (Deshmukh et al., 2021). Given this

under-diversification, CEOs are heavily exposed to the idiosyncratic risk of their firm. Therefore, non-overconfident CEOs are expected to exercise options that are in the money early rather than late (Hall and Murphy, 2002). However, overconfident CEOs consistently perceive their firm's stock to be undervalued; hence, they delay the exercise of their options, even when the latter are already deep in the money. Based on this argument, Malmendier and Tate (2005) define overconfident CEOs as those who hold exercisable options that are deep in the money.

Malmendier and Tate (2005) use a comprehensive but proprietary dataset to construct their CEO option-based measure. Unfortunately, ExecuComp does not provide such detailed data on the option holdings of CEOs. Hence, we use the modified version of Malmendier and Tate (2005), following the methodology of Campbell et al. (2011). First, we calculate the realizable value per option as the ratio of the total realizable value of the exercisable options to the number of exercisable options. Second, we subtract the per option realizable value from the stock price at the fiscal year-end to obtain an estimate of the average exercise price of the options. Third, to compute the average percentage moneyness of the options (*Option Moneyness*), we divide the realizable value per option by the estimated average exercise price. Malmendier and Tate (2005) classify CEOs as being overconfident if they hold exercisable stock options that are at least 67% in the money during the sample period. The choice of a 67% threshold comes from calibrating the Hall and Murphy (2002) model using a detailed dataset on CEOs' stock options holding and exercise decisions. In contrast, Campbell et al. (2011) define CEOs as being overconfident if the threshold exceeds 100% at least twice during the sample period. Unlike Campbell et al. (2011), we assume that overconfidence is a persistent characteristic; hence, we classify the CEO as overconfident if the CEO option moneyness exceeds 67% at least once during the sample period, which is in line with Hirshleifer et al. (2012).

4.3. Partial adjustment model: Testing the validity of hypothesis 1

The estimation of the SOA of cash holdings follows an approach similar to the dynamic partial adjustment model used in the capital structure literature (Byoun, 2008; Warr et al., 2012). For example, Dittmar and Duchin (2010) use such a model to examine the SOA of cash holdings over the firm's life cycle. Bates et al. (2018) and Jiang and Lie (2016) also employ such a model to examine the speed at which the levels of cash holdings change over time.

In line with the existing literature, we follow a two-step estimation procedure. It should be noted that, in what follows, we use the ratio of cash and short-term investments to total assets. The first step consists of estimating the target cash holdings ratio. The second step uses this estimated target cash holdings ratio to estimate a partial adjustment model of the firm's rebalancing decisions.

The simplest method for estimating a firm's target cash ratio is based on a pooled ordinary least squares (OLS) regression consisting of regressing the firm's cash holdings ratio on some firm-specific variables (Dittmar and Duchin, 2010). We estimate the regression for each of the years 1996 to 2020, resulting in 25 different annual regressions, to allow for time-varying determinants of optimal cash holdings. However, this method may still lead to biased coefficients if omitted variables affect the heterogeneity of cash holdings targets across firms. Therefore, we employ Fama–Macbeth cross-sectional regressions to estimate Eq. (1)⁷:

$$Cash_{i,t} = \sum_1^n \beta X_{i,t} + \varepsilon_{i,t}, \quad (1)$$

where *Cash* represents the cash holdings ratio for firm *i* in year *t*. *X* is a vector of firm, industry, and CEO characteristics. Our choice of variables coincides with Opler et al. (1999) and Bates et al. (2009), and we include the following variables: firm size, net working capital, industry cash

⁷ In Section 7, we use two alternative methods to estimate the target cash holdings ratio. First, we reestimate the dynamic panel data regressions using the system generalized method of moments (GMM) employing both equations in levels and in first differences, as well as the first-differenced GMM employing only first-differenced equations. Second, we reestimate the regressions while controlling for firm, industry, and year fixed effects, as well as addressing heteroscedasticity and autocorrelation concerns. Our main results remain qualitatively the same.

flow risk, cash flow, capital expenditures, Tobin's Q, the leverage ratio, a dividend indicator variable, and R&D expenditures. Following Dittmar and Duchin (2010) and Cheung (2016), we control for the effect of the firm's stage in its life cycle on cash policy by including firm age. Further, as per Hovakimian (2004), we include the median industry cash ratio as an additional control. We also include both stock return and stock volatility as control variables. Finally, we include additional variables representing CEO and board of directors characteristics—that is, CEO tenure, CEO ownership, CEO gender, CEO age, CEO vega, CEO delta, and the ratios of independent directors and female directors.

Some studies on capital structure (e.g., Cook and Tang, 2010; Devos et al., 2017) include the main variable of interest when estimating target leverage to check whether the results change compared with those obtained from a regression excluding this variable. Hence, we include our variable of interest (*Overconfidence*) in Eq. (1) to estimate the target cash holdings ratio. The reason for including the main variable of interest in the first-step regression is that overconfident CEOs may have a different view about what constitutes the target cash ratio than investors do (see also Section 3). Including the variable of interest in Eq. (1) would adjust for this.

The second step consists of using the estimated target cash holdings ratio from Eq. (1) to run the following partial adjustment model:

$$\Delta Cash_{i,t} = \lambda DevCash_{i,t} + \beta X_{i,t} + \varepsilon_{i,t} , \quad (2)$$

where $\Delta Cash_{i,t}$ represents the difference between the actual cash holdings ratio for the current year and the equivalent ratio for the last year ($Cash_{i,t} - Cash_{i,t-1}$). In addition, $DevCash_{i,t}$ represents the difference between this year's fitted cash holdings ratio and last year's actual cash holdings ratio ($Cash_{i,t}^* - Cash_{i,t-1}$). The coefficient λ represents the SOA, potentially ranging from 0 to 1. A value of 1 for λ indicates an immediate adjustment toward the optimal cash holdings ratio, whereas a value of 0 indicates no adjustment toward the target ratio.

Figure 1 examines the sample distribution of cash holdings levels for firms with and without overconfident CEOs. Each point represents a pair of firm-year observations for years t and $t-1$. In turn, the solid line represents the fitted values. As a comparison of Figure 1A and Figure 1B suggests, the distance between the observations and their fitted values for the subsample of overconfident CEOs is much greater, suggesting that overconfident CEOs are more likely to pile up cash and then spend it quickly. More importantly, Figure 1B also shows that there are more observations consisting of a positive cash holdings ratio in year t and a zero cash holdings ratio in year $t-1$ for the subsample of overconfident CEOs. In contrast, as Figure 1A confirms, firms with non-overconfident CEOs tend to be more consistent when it comes to the level of their cash holdings.

<INSERT FIGURE 1 HERE>

To further examine the impact of CEO overconfidence on the SOA of cash holdings, we interact the CEO overconfidence variable (i.e., *Overconfidence*) with the cash deviation variable as follows:

$$\Delta Cash_{i,t} = \alpha_1 + \beta_1 DevCash_{i,t} + \beta_2 Overconfidence_{i,t} + \beta_3 DevCash_{i,t} * Overconfidence_{i,t} + \beta X_{i,t} + \varepsilon_{i,t}, \quad (3)$$

where $\Delta Cash_{i,t}$ and $DevCash_{i,t}$ are defined as above, while *Overconfidence* is the CEO overconfidence measure. Our focus is on the coefficient on the interaction term (i.e., β_3). A positive (negative) sign for this coefficient indicates that CEO overconfidence increases (decreases) the SOA of cash holdings. A positive sign would provide support for hypothesis 1. The speed at which non-overconfident CEOs adjust their cash holdings can be interpreted as $\lambda = \beta_1$, whereas overconfident CEOs adjust their cash holdings at a speed of $\lambda = \beta_1 + \beta_3$.

4.4. Excess cash: Testing the validity of hypotheses 2A and 2B

To test the validity of the two competing hypotheses when firms hold cash balances beyond their optimum levels, we rerun Eq. (3) on the subsamples of firm-year observations for which actual cash holdings are above their optimal cash level.

5. Descriptive Statistics and Empirical Findings

5.1. Summary statistics

Table 1 provides summary statistics for the main variables used in this study. The first two columns provide the mean and median values for the full sample, whereas the next two columns report the mean and median values for the firm-year observations representing overconfident CEOs; the final two columns focus on the firm-year observations representing non-overconfident CEOs. We assign firm-year observations to the overconfident (non-overconfident) subsample if the *Overconfidence* indicator variable equals one (zero). This indicator variable is set to one if option moneyiness exceeds 67% at least once during the sample period and zero otherwise.

Out of the 17,478 firm-year observations, we have 11,884 (5,594) firm-year observations with overconfident (non-overconfident) CEOs. The table suggests that the subsample of overconfident CEOs is, on average, more likely to have a higher cash ratio, higher cash flow, and greater R&D expenditures compared with the subsample of non-overconfident CEOs. In addition, firms with overconfident CEOs are smaller, and have a lower propensity to pay dividends, a higher Tobin's Q, a higher industry sigma, and lower leverage than firms with non-overconfident CEOs do. The subsample of overconfident CEOs is characterized by CEOs with a longer tenure, a higher CEO vega and delta, more independent directors, and fewer female directors.⁸

<INSERT TABLE 1 HERE>

⁸ For detailed descriptive statistics of the variables used in this study, refer to Table A2 in the appendix.

5.2. Estimation of the partial adjustment model

Table 2 presents the results for the pooled ordinary least squares (OLS) and fixed effects panel regressions of the main determinants of cash holdings based on Eq. (1). These regressions are used to estimate the target cash holdings ratios for each firm. The first regression includes year fixed effects only, the second regression includes both year and industry fixed effects, and the last one includes both year and firm fixed effects.

The coefficients on *Overconfidence* in regressions (1) and (2) are negative and significant. This suggests a significantly negative effect of CEO overconfidence on the cash holdings level when including year and industry fixed effects. This association is not robust when year and firm fixed effects are included. These results are in line with Deshmukh et al. (2021), who report a negative association between the cash holdings level and CEO optimism. However, they contrast with the findings of Chen et al. (2020), who report a positive link between CEO overconfidence and the cash holdings ratio. Finally, most of the coefficients on the control variables are statistically significant, and their expected signs are in line with the findings of previous literature on cash holdings.

<INSERT TABLE 2 HERE>

Table 3 tests the validity of hypotheses 1, 2A, and 2B. This table presents the regression results estimating the SOA of cash holdings based on Eq. (2) and Eq. (3). Regressions (1) and (2) are estimated using the target cash ratio from Eq. (1). Whereas regression (1) includes year and industry fixed effects, regression (2) includes year and firm fixed effects.

In regression (1) of Table 3, the coefficient on the deviation from the optimal cash ratio (i.e., the SOA) is 0.170. Further, the coefficient on the deviation from regression (2) (i.e., the SOA), is 0.157. These values are similar to those of Dittmar and Duchin (2010), who find an SOA of 0.22.

We now focus on the effect of CEO overconfidence on SOA. The main variable of interest is the interaction term between *DevCash* and *Overconfidence*. In regressions (1) and (2), the interaction term *DevCash*Overconfidence* has a statistically significant coefficient with a positive sign in both cases. For example, for regression (1), the coefficient of 0.022 suggests that overconfident CEOs increase SOA, because it takes less time for firms with overconfident CEOs to revert to their target cash holdings. The positive effect of CEO overconfidence on SOA is 12.94% ($= 0.022 / 0.170$). Hence, it takes firms with overconfident CEOs eight months less to revert to their target cash holdings compared with firms with non-overconfident CEOs.⁹

In regressions (3) and (4), we test our two competing hypotheses, applying them to firms with cash holdings above their optimum level. Specifically, both regressions examine whether CEO overconfidence is positively associated with SOA when the actual cash holdings are above their optimal level. In both regressions, the interaction term *DevCash*Overconfidence* has a statistically significant coefficient with a positive sign. For regression (3), the coefficient of 0.04 suggests that overconfident CEOs increase the SOA, and the positive effect of CEO overconfidence on the SOA is 21.62% ($= 0.04 / 0.185$). Hence, it takes firms with overconfident CEOs and with cash holdings above their target level one year less to revert to their target cash holdings compared with firms with non-overconfident CEOs. This finding lends support to hypothesis 2A, but it calls for the rejection of competing hypothesis 2B.

Regressions (5) and (6) examine whether CEO overconfidence is significantly associated with SOA when the actual cash holdings are *below* their optimal level. The interaction term *DevCash*Overconfidence* does not have a statistically significant coefficient in either regression. Therefore, neither the cash savings view nor the quick dissipation of cash view holds for firms with cash holdings below their target levels. Overall, these results imply that overconfident CEOs

⁹ The difference in months is computed as $\left(\frac{1}{(\beta_1 + \beta_3)} - \frac{1}{\beta_1} \right) * 12$. A positive (negative) value indicates a longer (shorter) time period.

adjust their SOA faster when they have excess cash than when they have cash below the target level.

<INSERT TABLE 3 HERE>

6. Addressing Potential Endogeneity

The concern arises that our estimates might be biased because of the following: (i) endogenous matching of overconfident CEOs and corporate cash holdings levels and (ii) firms with overconfident CEOs potentially being fundamentally different from those with non-overconfident CEOs. To address these potential endogeneity issues, which all relate to sample selection bias, we perform the three tests described below.

6.1. DiD analysis based on an exogenous shock to firms' cash holdings

Overconfident CEOs may prefer to work for firms with a higher SOA of cash holdings. Nevertheless, the likelihood of this type of endogeneity (i.e., endogenous matching) is rather low; it is unlikely that CEOs only consider firms with specific dynamic cash policies when looking for a potential new employer. Still, to address this endogeneity concern, we identify an event causing an exogenous shock to firms' cash holdings.

We use the ratification of the 2012 KORUS FTA as a source of exogenous variation in firms' competitive environment. This agreement resulted in tariffs on US imports to South Korea and South Korean imports to the US being phased out.¹⁰ The rationale for choosing this event comes from the theoretical models of Morellec et al. (2014) and Della Seta (2011), predicting that cash holdings increase with increases in competition. Extant literature finds empirical support for this prediction, as it documents that competition increases corporate cash holdings.

¹⁰ The time it took to phase out the tariffs depended on the product category. There were 11 product categories ranging from tariffs being phased out immediately (or remaining at zero) to tariffs being phased out by year 15 of the agreement (year 1 being the first year of the agreement). Tariffs that were not phased out immediately were phased out gradually in equal annual stages up to the final year of the phasing-out period. See Chapter 2 of Final - United States - Korea FTA Texts at: <https://ustr.gov/trade-agreements/free-trade-agreements/korus-fta/final-text>.

More specifically, several studies use the KORUS FTA and find that it affects firms' cash holdings decisions (Fresard, 2010; Alimov, 2014; Zhang, 2020).

The KORUS FTA came into effect in 2013. The trade relations between the US and South Korea changed, without the existence of a related economic or political change in response to changes in macroeconomic conditions or pressures from individual companies.¹¹ Therefore, this agreement represents a quasi-natural experiment exploiting the elimination of tariffs between both countries across a large number of different industries. From the perspective of an individual firm, the agreement constitutes an exogenous and unanticipated shock to the firm's competitive environment. Thus, it makes sense to use this setting to assess the impact of CEO overconfidence on the SOA of cash holdings. The tariff dataset is sourced from World Integrated Trade Solution (WITS).¹²

Figure 2A shows a substantial drop in the overall average tariff rate from the year 2011 (pre-FTA) to the year 2014 (post-FTA). The average tariff rates were slightly below 4% in both 2011 and 2012 and then dropped to less than 1% in 2013 and 2014. In addition, Figure 2B shows a jump in the aggregate value of imports across industries from Korea to the US. Imports amounted to less than \$60 billion in both 2011 and 2012, increased to around \$65 billion in 2013, and exceeded \$70 billion in 2014. This pattern further validates the use of this agreement as a source of exogenous shock to corporate cash holdings.

<INSERT FIGURE 2 HERE>

Following Alimov (2014), we merge our dataset with the tariff data based on the two-digit SIC industry codes. We then divide the industries into three groups with respect to the pre-FTA tariff levels. While the phasing-out periods varied across industries, and thus, may not have been

¹¹ For a further discussion on the validity of FTAs as exogenous shocks, see Guadalupe and Wulf (2010) and Alimov (2014). In addition, Ramelli and Wagner (2020) refer to the dependence of firms on trade linkages that could influence corporate value and cash holdings decisions.

¹² WITS was developed by the World Bank, with the help of the United Nations Conference on Trade and Development (UNCTAD) and in consultation with the International Trade Center, the United Nations Statistical Division (UNSD), and the World Trade Organization (WTO) (see <https://wits.worldbank.org/>).

endogenous, this approach ensures that all industries are treated in the same way. The pre-FTA tariffs (i.e., the 2011 tariffs) at the two-digit SIC industry level ranged from 0% to 10.37%. We define high-tariff industries as those that were in the top tercile of the pre-FTA tariffs (above 2%); low-tariff industries were in the bottom tercile of the pre-FTA tariffs (below 0.1%).

To further confirm that greater competition is associated with higher cash holdings, we run a mean comparison test between firms with high and low import tariffs. In untabulated results, we find that, after the FTA agreement, firms originally subject to high tariffs have significantly (at the 5% level) higher ratios of both actual and optimal cash holdings compared with those subject to low tariffs.

Via a DiD analysis, we compare the SOA of cash holdings in the years before and after the FTA (first difference) between firms with a greater increase in competitive pressure because of a reduction in tariffs and those with a lower increase (second difference). We do this for the two subsamples of firm-year observations with and without overconfident CEOs. Therefore, we create an indicator variable, *HighTariff*, to identify the firms in industries in the top tercile of the pre-FTA tariffs. This variable equals one if the firm belongs to an industry with a pre-FTA tariff above 2% and zero otherwise. Finally, we create another indicator variable (*PostFTA*) that equals one for observations in the post-2012 period and zero otherwise.

We estimate regressions based on Eq. (4) for the subsample of firm-year observations with overconfident CEOs and the subsample of firm-year observations with non-overconfident CEOs:

$$\begin{aligned} \Delta \text{Cash}_{i,t} = & \alpha_1 + \beta_1 \text{DevCash}_{i,t} + \beta_2 \text{HighTariff}_{i,t} + \beta_3 \text{PostFTA}_{i,t} + \beta_4 \text{DevCash}_{i,t} * \\ & \text{PostFTA}_{i,t} + \beta_5 \text{DevCash}_{i,t} * \text{HighTariff}_{i,t} + \beta_6 \text{PostFTA}_{i,t} * \text{HighTariff}_{i,t} + \\ & \beta_7 \text{DevCash}_{i,t} * \text{PostFTA}_{i,t} * \text{HighTariff}_{i,t} + \beta X_{i,t} + \varepsilon_{i,t}, \end{aligned} \quad (4)$$

Regressions (1) and (2) in Table 4 provide the results. The triple interaction term *DevCash*PostFTA*HighTariff* captures the incremental impact of the trade agreement on the SOA of cash holdings for firms that experience relatively large tariff reductions on Korean imports compared with those that experience relatively small tariff reductions.

Regression (1) reveals a positive and strongly significant (at the 1% level) coefficient on the interaction term for the subsample of firm-year observations with overconfident CEOs. In contrast, the coefficient on the same interaction term is not statistically significant for the subsample of firm-year observations with non-overconfident CEOs in regression (2). These findings imply that, following this exogenous shock, overconfident CEOs of firms subject to larger tariff reductions post-FTA appear to have increased the SOA of cash holdings. These results further support our main finding (i.e., evidence in favor of hypothesis 1) that CEO overconfidence increases SOA.

<INSERT TABLE 4 HERE>

6.2. DiD analysis based on CEO turnover

To strengthen our causal inferences further, we employ another DiD analysis to explore the impact of CEO turnover on the relationship between overconfident CEOs and SOA. Specifically, we examine how the substitution of a non-overconfident CEO with an overconfident counterpart influences the relationship in question. To this end, we follow Chen et al. (2023) and create two groups. The treatment group comprises firms that underwent CEO turnover, resulting in the replacement of the non-overconfident CEO by an overconfident CEO. The control group includes firms with CEO turnover, either replacing a non-overconfident CEO with another non-overconfident CEO or substituting an overconfident CEO with another overconfident CEO.

Subsequently, we define two key variables as follows: (i) *Treatment*, an indicator variable set to one for the treatment firms and zero for the control firms, and (ii) *PostTurnover*, an indicator variable set to one for the three years subsequent to the CEO turnover and zero for the three years preceding the CEO turnover. We then create an interaction term for *Treatment* and *PostTurnover*. We reestimate our baseline model by replacing *Overconfidence* with this interaction term. The coefficient on *Treatment*PostTurnover* captures the treatment effect, revealing how replacing a non-overconfident CEO with an overconfident CEO influences SOA.

The results are reported in regression (3) of Table 4. The coefficient of interest (i.e., *Treatment*PostTurnover*) is positive and significant at the 1% level. This provides further support for hypothesis 1 that the presence of CEO overconfidence increases the firm's SOA of cash holdings.

<INSERT TABLE 4 HERE>

6.3. Matching and reweighting

Firms with overconfident CEOs may be fundamentally different from those with non-overconfident CEOs. Table 1 gives credence to this argument, given the significant differences in the means for various firm characteristics between the two types of firms. Although we include various control variables in our main regressions, our results could still be biased, as they might be due to *nonlinear* effects of the control variables on the SOA of cash holdings. To address this concern, we ensure that the firm-year observations relating to overconfident CEOs are comparable to those relating to non-overconfident CEOs. To do this, we implement PSM as the matching procedure and EB as the reweighting procedure.

First, we carry out PSM by matching firm-year observations involving overconfident CEOs with firm-year observations with similar characteristics but without involving overconfident CEOs. Specifically, we run a logistic regression to estimate the propensity scores (i.e., $p(Y=1|X=x)$), based on the probability of receiving a binary treatment (i.e., Y) conditional on all the control variables (i.e., X). We consider firm-year observations with overconfident CEOs as having received the “treatment,” and we estimate the probability of having an overconfident CEO using a set of independent variables. The explanatory variables are the same as those used in regression (1) of Table 3.¹³

¹³ To test for the validity of the conditional independence assumption, in untabulated analysis, we reestimate the logistic regression for our post-match sample. If this assumption is satisfied, then, after controlling for the observed firm characteristics, the assignment of units to the treatment is as good as random (Lechner, 1999). Except for *Independent Directors*, the regression coefficients for the post-match sample are not statistically significant. The pseudo R^2 also decreases substantially from 0.100 for the pre-match sample to 0.004 for the post-match sample.

For each firm-year observation with an overconfident CEO, we use the propensity scores obtained from the logistic regression to find a comparable firm-year observation with a non-overconfident CEO, while matching to the nearest neighbor; more specifically, we employ one-to-one matching without replacement. To ensure the quality of the matching, we require that the caliper (i.e., the absolute difference in propensity scores) among pairs does not exceed 5% of one standard deviation of the propensity score. If there is more than one potential match for a firm-year observation with an overconfident CEO, we retain the firm-year observation with the smallest difference in the propensity scores. Further, we make sure that, for each value of a control variable, there is a positive probability of being treated and untreated. In other words, we consider only those observations whose propensity score belongs to the intersection of the supports of the propensity scores of treated and controls, thereby satisfying the common support condition (Caliendo and Kopeinig, 2008). We obtain 4,851 pairs of matched firm-year observations.

Next, using the matched sample, we rerun the regression based on Eq. (3) to verify whether the relationship in question still holds. Regression (4) of Table 4 reveals that the interaction between the deviation from the target cash level (*DevCash*) and CEO overconfidence (*Overconfidence*) is significant (at the 5% level) and positive. This finding is qualitatively similar to the findings reported in Table 3. Thus, it provides further support for hypothesis 1.

Second, we employ EB (Hainmueller, 2012) to control for the observable differences between firms with overconfident and non-overconfident CEOs. In practice, the success of PSM relies on the quality of the estimated propensity scores. However, the literature does not agree as to how the estimation of the propensity score is best conducted (Imai et al., 2008). Therefore, in essence, it is left to the researcher to “manually” iterate between propensity score modeling, matching, and balance checking until a satisfactory balancing solution score is obtained, without

These results indicate that, by using PSM, we successfully remove the differences in the observable characteristics other than the differences in CEO overconfidence.

a guarantee of finding such a satisfactory solution. Further, it is argued that PSM may counteract the reduction in the bias for the subsequent treatment effect estimation, because improving the balance on some variables decreases the balance on the other variables (Diamond and Sekhon, 2006; Ho et al., 2007).

To overcome these issues, Hainmueller (2012) proposes the use of EB, which directly incorporates variable balance in the estimation procedure in an iterative manner, making the need to check variable balance repeatedly redundant. Hence, this method is more robust than PSM in tackling selection bias as one of the endogeneity concerns. For each variable, we use the first-order moment (i.e., the mean) to achieve balance. The results obtained from regression (5) of Table 4 again confirm our main results. We conclude that the results obtained from applying PSM and EB provide further support for hypothesis 1 and mitigate the concern about sample selection bias.

7. Robustness Tests

7.1. Alternative CEO overconfidence measures

To gauge the robustness of our results, we start by examining the sensitivity of our main findings to the use of six alternative measures of CEO overconfidence. First, we use two investment-based measures of CEO overconfidence, based on residual investment and capital expenditure, respectively. Malmendier and Tate (2005) highlight that overconfident CEOs often overestimate the profitability of investment prospects, leading to excessive investment. Therefore, in line with prior studies (e.g., Ahmed and Duellman, 2013; Chen et al., 2023), residual investment (*Resid_Invest*) is constructed as the first measure by regressing the asset growth rate on the sales growth rate to obtain the regression's residual. Then, an indicator variable is created that takes a value of one if the residual is positive and zero otherwise. The second investment-based measure is related to capital expenditure. *Capex_Invest* is an indicator variable set to one if the capital

expenditures ratio (capital expenditures in year t divided by total assets in year $t-1$) of the firm is larger than the median industry ratio and zero otherwise.

Second, following previous studies, such as those of Aktas et al. (2019), Banerjee et al. (2015), and Hirshleifer et al. (2012), we use three alternative CEO overconfidence measures based on option moneyness. The first measure is a continuous variable of the option-based overconfidence measure (i.e., *CEO_Cont*), computed as the average value of the CEO's in-the-money options divided by the average strike price (Banerjee et al., 2015). The second measure is *Holder67*, an indicator variable equal to one for all the years after the year when the CEO holds options that are at least 67% in the money and zero otherwise (Hirshleifer et al., 2012). The third option-based overconfidence measure is *High_Conf*. Following Aktas et al. (2019), we define this measure as an indicator variable equal to one if the CEO holds options until the year of their expiration at least once during his or her tenure period and the stock options' value is greater than or equal to the threshold of the 25th percentile in-the-money option value of the sample.

Finally, following Schrand and Zechman (2012) and Chen et al. (2023), we use a composite measure of CEO overconfidence. In line with Schrand and Zechman (2012), we define *CEO_Composite* as an indicator variable equal to one if the firm satisfies at least two of the following criteria in the given year: i) It exhibits excess investment compared with its primary industry, ii) its merger and acquisition activity surpasses the industry median, iii) its debt-to-equity ratio exceeds the industry median, and iv) it has convertible debt or preferred stock outstanding. This variable is set to zero otherwise.

The results of these estimations are reported in Table 5. The robustness tests reveal that the coefficient on all six alternative CEO overconfidence measures is positive and significant, confirming that our baseline findings are robust to alternative measures of CEO overconfidence.

<INSERT TABLE 5 HERE>

7.2. Alternative estimation methods

Given that a reliable estimation of the target cash holdings ratio is vital for our study, we conduct robustness tests using two alternative methods to estimate the optimal cash holdings ratio for each firm. First, we employ two dynamic panel data estimation techniques—the Blundell and Bond (1998) system GMM and the Arellano and Bond (1991) first differenced GMM—using all the variables lagged $t-3$ as instruments for the equations in levels and all the variables lagged $t-4$ as instruments for the equations in differences. This approach allows us to control for potential omitted variable bias, as well as simultaneous and dynamic endogeneity (Wintoki et al., 2012; Abdallah et al., 2015), in the first step, where we use Eq. (5) to estimate the optimal cash holdings ratios:

$$\text{Cash}_{i,t} = (1 - \lambda)\text{Cash}_{i,t-1} + \gamma_n \sum_1^n \text{Control Variables}_{i,t-1} + \varepsilon_{i,t}. \quad (5)$$

We then include the estimated values in Eq. (3) to estimate the firm's SOA of cash holdings.

Second, we use the Driscoll and Kraay (1998) estimator. In the first step, using this estimator permits us to estimate the target cash holdings ratio, while controlling for heteroscedasticity and autocorrelation, assuming that the standard errors are heteroscedastic, autocorrelated up to some lags, and possibly correlated between groups (Jiang and Lie, 2016). This estimator allows us to correct for the presence of cross-sectional correlation. In the second step, we include this estimated value using the Driscoll and Kraay (1998) estimator in Eq. (3) to estimate the firm's SOA of cash holdings.

Table 6 reports the estimated results from Eq. (3) using the optimal cash holdings, which were obtained from Eq. (5). The results are similar to our previous findings: We continue to find a significantly positive association for the interaction term *DevCash*Overconfidence* for each of the three alternative estimation techniques, providing further support for the first hypothesis.

<INSERT TABLE 6 HERE>

8. Additional Analyses

This section discusses the impacts of financial constraints, the level of debt financing, and corporate governance on the relation between SOA and CEO overconfidence.

8.1. Financial constraints

Bates et al. (2018) find that financial constraints affect the speed at which firms adjust their cash holdings toward the target ratio over time. They report a decline in the SOA for financially constrained firms—that is, firms with cash deficits in the 1990s and 2000s. In this section, we examine the effect of financial constraints on the relationship between CEO overconfidence and the SOA of cash holdings. Since overconfident CEOs believe that external financing is overly costly, they are expected to act as if their firms were financially constrained (Deshmukh et al., 2021). Hence, they rely more heavily on internal funding. Therefore, *actual* financial constraints further amplify the biased belief of overconfident CEOs about the high cost of external financing and make them rely even more heavily on internal funds; as a result, the SOA of cash holdings increases.¹⁴ In sum, since financially constrained firms face difficulties in raising external funds, the SOA of such firms should be faster.

Further, Aktas et al. (2019) study the effect of CEO overconfidence on the value of cash when controlling for financial constraints. In support of the costly external finance hypothesis, they find a positive effect of CEO overconfidence on the value of cash holdings for financially constrained firms. In contrast, for financially unconstrained firms, they find overconfident CEOs to affect the value of cash holdings negatively, suggesting overinvestment.

To examine how CEO overconfidence affects the SOA of cash holdings in the presence of financial constraints, we reestimate Eq. (3) after dividing our sample into financially constrained and unconstrained firm-year observations. Following the existing literature (Almeida et al., 2004;

¹⁴ Similarly, the capital structure literature suggests that the costs of adjusting leverage toward its target differ between financially constrained and unconstrained firms (Faulkender and Petersen, 2006; Faulkender et al., 2012).

Farre-Mensa and Ljungqvist, 2016; Aktas et al., 2019; Dong et al., 2020), we classify firms according to whether they are internally and externally financially constrained. We define firms as internally financially constrained if they do not make dividend payments. In particular, for each year, we assign a firm-year observation to the internally financially constrained subsample if the firm does not pay a dividend in that year. For externally financially constrained firms, we use the absence of credit ratings as a proxy for financial constraints (see Aktas et al., 2019; Acharya and Steffen, 2020). More specifically, for each year, we define externally financially constrained firms as those without a credit rating.¹⁵ We expect the interaction between *DevCash* and *Overconfidence* to be significant and more positive for financially constrained firms because such firms are expected to have a faster SOA.

The constraints measure given in the first two columns of Table 7 is based on internal financial constraints proxied by the absence of dividend payments. In regression (1), for financially constrained firms, the coefficient on the interaction term is significantly positive, while it is not significant in regression (2), for unconstrained firms. For the former, the size of this coefficient (0.029) suggests that the effect is economically significant; CEO overconfidence increases the SOA by 16.11% ($= 0.029/0.180$). It takes about eight months less for overconfident CEOs of financially constrained firms to move toward their target cash holdings.

When we divide the sample according to the presence of external financial constraints (i.e., the absence of credit ratings; regressions (3) and (4)), the coefficient on the interaction between *DevCash* and *Overconfidence* is significant and positive for the financially constrained firms (regression (3)) but not for the unconstrained firms (regression (4)). The coefficient in regression (3) is also economically significant; CEO overconfidence increases the SOA by 13.22% ($= 0.023/0.174$). Overall, these results suggest that both internal and external financial constraints significantly increase the SOA of cash holdings in the presence of CEO overconfidence.

<INSERT TABLE 7 HERE>

¹⁵ The definition of each financial constraint proxy is reported in Table A1 of the appendix.

8.2. The role of debt financing

Another factor that may affect the SOA of cash holdings is a firm's capital structure. Dittmar and Duchin (2010) view cash holdings as negative debt, with the firm managing its cash and debt levels jointly rather than separately from each other. The relationship between a firm's debt level and the SOA of cash holdings could then be explained by two competing arguments. On the one hand, higher levels of debt may make cash holdings less important, as the firm has access to debt (i.e., a source of funding). Given this substitutability between cash holdings and debt (Strebulaev and Yang, 2013), the SOA of cash holdings is expected to be lower when debt levels are high (Dittmar and Duchin, 2010). On the other hand, firms with high leverage should have lower adjustment costs for cash, and hence, a higher SOA of cash holdings. Dittmar and Duchin (2010) find supporting evidence for the latter argument, as greater liquidity, measured by the firm's access to a revolving credit facility, is associated with a higher SOA of cash holdings. The question then arises of whether, after controlling for different levels of debt, CEO overconfidence still affects SOA. We attempt to answer this question by dividing our sample into two subsamples according to whether the leverage ratio is below or above the sample median.

Acharya et al. (2012) argue that a firm can be regarded as a portfolio of assets, with cash being one of the assets. In turn, the assets structure of this portfolio depends on the composition of the firm's liabilities (i.e., the firm's debt structure). Acharya et al. (2012) find that firms with greater credit risk have larger cash holdings. Similarly, the literature on debt structure highlights the importance of credit risk and information asymmetry for a firm's debt decisions (e.g., Bali and Skinner, 2006; Hackbarth et al., 2006; Daniels et al., 2010). For example, a survey by Graham and Harvey (2001) shows that managers care most about the firm's credit ratings and financial flexibility when making debt issuance decisions. One would expect that controlling for credit risk is especially important when debt is high. Therefore, we include a measure of credit risk, *CreditRisk*, and interact it with *DevCash*Overconfidence* in both the subsample with high

debt and that with low debt. *CreditRisk* is an indicator variable that equals one if the interest coverage ratio is lower than two and zero otherwise. The interest coverage ratio is defined as earnings before interest and tax (EBIT) divided by interest expenses.

We use a regression based on Eq. (6) to test for a differential SOA for firms with high debt levels and those with low debt levels, while considering the credit risk:

$$\begin{aligned} \Delta \text{Cash}_{i,t} = & \alpha_1 + \beta_1 \text{DevCash}_{i,t} + \beta_2 \text{Overconfidence}_{i,t} + \beta_3 \text{DevCash}_{i,t} * \\ & \text{Overconfidence}_{i,t} + \beta_4 \text{CreditRisk}_{i,t} + \beta_5 \text{DevCash}_{i,t} * \text{CreditRisk}_{i,t} + \\ & \beta_6 \text{Overconfidence}_{i,t} * \text{CreditRisk}_{i,t} + \beta_7 \text{DevCash}_{i,t} * \text{Overconfidence}_{i,t} * \\ & \text{CreditRisk}_{i,t} + \beta X_{i,t} + \varepsilon_{i,t}, \end{aligned} \quad (6)$$

Regressions (5) and (6) in Table 7 suggest that the SOA is higher for firm-year observations with an above-median debt level (0.221) compared with firm-year observations with a below-median debt level (0.166). This suggests that above-median levels of debt reflect reduced financial constraints, resulting in lower adjustment costs for cash holdings and a greater SOA. Therefore, firms with above-median levels of debt are more likely to be close to their target cash holdings ratio, as well as reverting quickly to it should they be pushed away from it. These results support the findings of Dittmar and Duchin (2010) and Jiang and Lie (2016).

In regression (5), which is based on below-median levels of debt, the regression coefficient on the triple interaction term *DevCash*Overconfidence*CreditRisk* is statistically significant (at the 1% level) and positive, with a value of 0.157. The speed at which overconfident CEOs of firms with high credit risk adjust their cash holdings is given by $\lambda = \beta_1 + \beta_3 + \beta_5 + \beta_7$. In turn, the SOA for overconfident CEOs of firms with low credit risk is $\lambda = \beta_1 + \beta_3$. Hence, the SOA for firms with overconfident CEOs and high credit risk is 0.245 (= 0.166 + 0.002 – 0.08 + 0.157), whereas the SOA for firms with overconfident CEOs and low credit risk is only 0.168 (= 0.166 + 0.002). Therefore, there is some evidence that CEO overconfidence in the below-average debt subsample increases the SOA when credit risk is high. In contrast, the positive association between managerial overconfidence and SOA is more apparent for firms with higher

indebtedness, regardless of credit risk (see regression (6)). However, again, for firms with lower indebtedness, overconfident managers increase the SOA only when credit risk is high.

<INSERT TABLE 7 HERE>

8.3. Corporate governance quality

According to the extant literature, the quality of the firm's governance plays a role in its cash holdings policy. For example, Dittmar and Mahrt-Smith (2007) and Kalcheva and Lins (2007) find that good governance practices have a positive effect on the value of cash holdings. They further report that poorly governed firms dissipate cash quickly in ways that significantly reduce their operating performance, whereas this is not the case for well-governed firms. Aktas et al. (2019) also control for the firm's governance when examining the impact of CEO overconfidence on the value of cash holdings. They find that corporate governance quality matters. Hence, we reestimate Eq. (3) by considering the quality of the firm's governance. To this end, we divide our sample into subsamples of firm-year observations with good and bad governance. Following the existing literature, we define the quality of corporate governance by the CEO duality indicator variable *Duality*, where CEO duality is assumed to reflect bad corporate governance (Dahya et al., 2002; Aktas et al., 2019).

If the firm's governance impacts the relation between CEO overconfidence and the SOA of cash holdings, we expect the interaction between *DevCash* and *Overconfidence* to be significant and more positive for firms with good governance. This is because such firms are expected to have a faster SOA.

The results are provided in regressions (7) and (8) of Table 8. In regression (8) for the subsample of firm-year observations with good governance (i.e., without duality), the coefficient on the interaction between *DevCash* and *Overconfidence* is significant and positive. This suggests that, for well-governed firms with overconfident CEOs, the SOA increases by 31.68% ($= 0.051 / 0.161$). Specifically, it takes about 18 months less for such firms to move toward the

target cash holdings level. In contrast, the results from regression (7) indicate that, for firms with bad governance, CEO overconfidence reduces the SOA. The coefficient on the interaction term is negative and significant. This suggests that the reduction in the SOA amounts to 16% ($= 0.032 / 0.200$). Therefore, it takes about 11 months longer for overconfident CEOs working in firms with bad governance to move toward their target cash holdings.

<INSERT TABLE 7 HERE>

9. Conclusion

In the cash holdings literature, the association between managerial overconfidence and cash holdings levels, as well as the incremental value of holding additional cash, have been examined. However, the relevance of CEO overconfidence for the SOA of cash holdings levels has not been studied. Our study fills this gap. The key finding of the study was that CEO overconfidence plays a significant role in affecting the SOA of the cash holdings of listed US firms. We found that overconfident CEOs increase the speed at which their firm adjusts toward its target cash ratio: On average, firms managed by overconfident CEOs take eight to nine months less to adjust toward their target cash holdings ratio compared with firms managed by non-overconfident CEOs. Further, we found supporting empirical evidence that overconfident managers quickly dissipate excess cash, leading to a higher SOA. Therefore, our results do not lend support to the cash savings view, whereby overconfident CEOs pile up cash as a result of what they perceive to be prohibitively costly external borrowing.

Our findings suggested that, if the actual cash holdings deviate from their target level, overconfident CEOs increase SOA. Further, our subsample analyses suggested that this positive effect of CEO overconfidence on SOA stems from firms subject to internal or external financial constraints, firms with good governance, and firms with a combination of both low leverage and high credit risk.

Importantly, we attempted to address various endogeneity concerns relating to sample selection bias. To this end, we implemented a DiD analysis using the 2012 KORUS FTA as an exogenous shock. A second DiD analysis consisted of studying the substitution of a non-overconfident CEO with an overconfident counterpart. We also implemented PSM to match firm-year observations with overconfident CEOs to firm-year observations with non-overconfident CEOs using firm characteristics. As an alternative approach, we used EB to avoid any bias inherent in PSM; our results remained robust. In addition, our results were found to be robust to the use of various alternative definitions of the target cash holdings ratio, alternative measures for CEO overconfidence, and the inclusion of control variables for the quality of the firm's governance. Overall, our study highlights the importance of CEO overconfidence in the SOA of cash holdings.

This paper provides policy implications for decision-makers and avenues for future academic research. As evidenced by Malmendier et al. (2011) and Schoar and Zuo (2017), among others, CEO overconfidence impacts many aspects of corporate decision-making and behavior, and hence, corporate outcomes. By studying corporate cash holdings, we provide further evidence that this personality trait does matter. Therefore, future studies should attempt to relate this managerial bias to other aspects of corporate decision-making by top executives (see, for instance, Adam et al. (2015) on risk management). There is also a need for cross-country studies to unearth any potential differential effects of CEO overconfidence on corporate decisions and outcomes across different cultural, legal, and institutional environments. If this self-enhancement bias is deemed to be persistent—say, because of cognitive dissonance—and prevalent enough among individuals, corporate boards of directors and shareholders may want to take this bias into account when appointing a CEO.

Our empirical analyses are based on listed US firms. However, in terms of generalizability, the significance, pertinence, and applicability of our findings can feasibly be extended to other economies, such as those of Europe.

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Table 1. Descriptive statistics

This table reports the summary statistics for the entire sample, as well as the subsamples of firm-year observations corresponding to overconfident and non-overconfident CEOs. The sample consists of 17,478 firm-year observations for the period 1996–2020. The *t*-tests (Wilcoxon–Mann–Whitney *z*-tests) were conducted to test for differences in means (medians) between firm-year observations with overconfident and non-overconfident CEOs. All nonbinary variables are winsorized at the 1st and 99th percentiles. ***, **, and * denotes a statistically significant difference at the 1%, 5%, and 10% levels, respectively. Table A1 defines the variables.

	Entire Sample		Overconfidence = 1		Overconfidence = 0	
	Mean	Median	Mean	Median	Mean	Median
Overconfidence	0.680	1				
Cash	0.152	0.094	0.156***	0.095***	0.145	0.091
Size (\$ million)	7951.3	1810.2	7179.9***	1774.8***	9589.9	1913.3
Tobin's Q	2.128	1.714	2.268***	1.835***	1.830	1.506
Dividend	0.580	1	0.551***	1***	0.642	1
IndSigma	0.224	0.087	0.236***	0.089***	0.198	0.079
CF	0.092	0.096	0.098***	0.102***	0.080	0.086
NWC	0.116	0.101	0.119***	0.106***	0.110	0.091
CAPEX	0.049	0.035	0.05***	0.036***	0.047	0.033
Leverage	0.221	0.213	0.214***	0.204***	0.236	0.227
R&D	0.033	0.006	0.035***	0.007***	0.028	0.004
Acquisitions	0.032	0.002	0.033***	0.003***	0.027	0.001
Age (years)	29.336	25	28.075***	24***	32.016	28
Return	0.0002	0.001	0.0004***	0.001***	-0.0002	0.0004
Return Volatility	0.081	0.035	0.081	0.035***	0.081	0.034
CEO Tenure (years)	8.682	6.000	9.777***	8***	6.357	4
CEO Ownership	0.018	0.003	0.018	0.004***	0.018	0.002
CEO Gender	0.969	1	0.974***	1***	0.958	1
CEO Age	56.176	56	56.186	56	56.153	56
CEO Vega (\$ thousands)	123.26	44.524	139.139***	57.522***	89.539	15.581
CEO Delta (\$ thousands)	633.72	187.11	743.853***	261.792** *	399.739	79.720
Independent Directors	0.675	0.750	0.685***	0.750	0.653	0.750
Female Directors	0.131	0.125	0.124***	0.111***	0.147	0.125
No. of Observations	17,478	17,478	11,884	11,884	5,594	5,594

Table 2. Determinants of the cash holdings ratio

This table reports the determinants of the optimal level of cash holdings, in addition to CEO overconfidence. Regression (1) controls for year fixed effects (FE) only. Regressions (2) and (3) control for year and industry effects, whereas regression (3) controls for year and firm FE. The dependent variable is the cash ratio (*Cash*). Control variables include the firm-, CEO-, and board of directors-related characteristics, as per Eq. (1). See the appendix for definitions of the variables. Year, industry, and firm fixed effects are controlled for in the regressions as indicated. ***, **, and * denotes a statistically significant difference at the 1%, 5%, and 10% levels, respectively. Standard errors robust to clustering by firm are reported in parentheses.

	Ordinary Least Squares (OLS)		FE
	Year FE	Year & Industry FE	Year & Firm FE
	(1)	(2)	(3)
Overconfidence	-0.012*** (0.004)	-0.012*** (0.004)	-0.004 (0.003)
Size	-0.006** (0.002)	-0.005** (0.002)	-0.019*** (0.003)
Tobin's Q	0.023*** (0.002)	0.024*** (0.002)	0.013*** (0.002)
Dividend	-0.026*** (0.005)	-0.024*** (0.005)	-0.009** (0.004)
IndSigma	-0.004 (0.003)	-0.000 (0.002)	0.001 (0.002)
CF	-0.031 (0.023)	-0.047** (0.022)	-0.029* (0.016)
NWC	0.143*** (0.023)	0.187*** (0.026)	0.183*** (0.021)
CAPEX	-0.361*** (0.042)	-0.485*** (0.044)	-0.464*** (0.036)
Leverage	-0.171*** (0.014)	-0.146*** (0.014)	-0.074*** (0.013)
R&D	0.983*** (0.059)	0.851*** (0.063)	0.167*** (0.051)
Acquisition	-0.294*** (0.017)	-0.280*** (0.016)	-0.202*** (0.011)
Age	-0.021*** (0.004)	-0.020*** (0.004)	-0.033*** (0.005)
Return	0.084 (0.176)	-0.036 (0.116)	0.148** (0.067)
Return Volatility	-0.049** (0.021)	-0.050** (0.021)	-0.094*** (0.025)
CEO Tenure	0.001* (0.000)	0.001* (0.000)	0.000 (0.000)
CEO Ownership	0.140* (0.084)	0.166** (0.081)	0.019 (0.052)
CEO Gender	-0.032** (0.014)	-0.021 (0.013)	-0.008 (0.007)
CEO Age	-0.001 (0.000)	-0.000 (0.000)	-0.001** (0.000)
CEO Vega	0.013 (0.011)	0.016 (0.010)	0.001 (0.007)
CEO Delta	-0.001 (0.002)	-0.002 (0.002)	-0.001 (0.002)
Independent Directors	0.022* (0.013)	0.026** (0.013)	0.021** (0.008)
Female Directors	-0.021 (0.022)	-0.019 (0.021)	-0.015 (0.014)
Constant	0.263*** (0.031)	0.217*** (0.043)	0.382*** (0.029)
Year FE	Yes	Yes	Yes
Industry FE	No	Yes	No
Firm FE	No	No	Yes
Observations	17,478	17,478	17,478
Adj. R^2	0.470	0.516	0.356

Table 3. Effect of CEO overconfidence on the speed of adjustment (SOA) of cash holdings

This table presents the regressions of CEO overconfidence on the adjustment speed for the cash ratios. The dependent variable is the annual change in the cash ratio ($\Delta Cash$). *DevCash* is the difference between target cash holdings and actual cash holdings. *Overconfidence* is an indicator variable measuring CEO overconfidence; it is set to one if *Option Moneyiness* exceeds 67% at least once during the sample period and zero otherwise. *Controls* includes the control variables representing firm (i.e., *Size*, *Tobin's Q*, *Dividend*, *IndSigma*, *CF*, *NWC*, *CAPEX*, *Leverage*, *Research and Development [R&D]*, *Acquisition*, *Age*, *Return*, *Return Volatility*), CEO (*Tenure*, *Ownership*, *Gender*, *Age*, *Vega*, *Delta*), and board characteristics (*Independent Directors*, *Female Directors*), as per Eq. (1). Regressions (1) and (2) test the validity of hypothesis 1. Regressions (3) and (4) ((5) and (6)) test the validity of hypothesis 2A (2B) when running Eq. (3) on the subsample of firms conditional on firms having cash that is above (below) the optimal cash level. Year, industry, and firm fixed effects (FE) are included in the regressions as indicated. ***, **, and * denotes a statistically significant difference at the 1%, 5%, and 10% levels, respectively. Standard errors robust to clustering by firms are reported in parentheses.

	Full Sample		Cash Above the Target		Cash Below the Target	
	(1)	(2)	(3)	(4)	(5)	(6)
DevCash	0.170*** (0.007)	0.157*** (0.007)	0.185*** (0.015)	0.214*** (0.016)	0.247*** (0.020)	0.143*** (0.018)
Overconfidence	0.001 (0.001)	0.001 (0.001)	0.004 (0.003)	0.003 (0.003)	0.001 (0.002)	-0.000 (0.002)
DevCash*Overconfidence	0.022** (0.009)	0.020** (0.009)	0.040** (0.018)	0.034* (0.019)	0.025 (0.022)	0.024 (0.020)
Constant	-0.007 (0.016)	0.017** (0.007)	0.006 (0.028)	0.049*** (0.015)	0.018* (0.010)	0.009 (0.019)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	No	Yes	No	Yes	No
Firm FE	No	Yes	No	Yes	No	Yes
Observations	17,478	17,478	6,946	6,946	10,532	10,532
Adj. R^2	0.263	0.256	0.356	0.35	0.13	0.111

Table 4. Tests for endogeneity considerations

This table presents the results of the endogeneity-related tests. Regressions (1) and (2) are related to the difference-in-differences (DiD) analysis using the 2012 US–Korea Free Trade Agreement (KORUS FTA) as an exogenous shock. *HighTariff* is an indicator variable that equals one if the firm experiences tariff reductions following the FTA in excess of 2% (top tercile of the tariff distribution) and zero otherwise. *PostFTA* is an indicator variable that equals one for observations in the post-2012 period and zero otherwise. The estimation in regression (3) is related to the DiD analysis of CEO turnover. *Treatment* is an indicator variable equal to one for treatment firms and zero for control firms. Firms in the treatment group are those that experienced a CEO turnover in which a non-overconfident CEO was replaced with an overconfident CEO. Firms in the control group are those that experienced a CEO turnover but either replaced a non-overconfident CEO with another non-overconfident CEO or replaced an overconfident CEO with another overconfident CEO. *PostTurnover* is an indicator variable that is equal to one for the next three years following CEO turnover and zero for the three years preceding CEO turnover. The estimations in regressions (4) and (5) are related to the matching estimation tests. They present the propensity score matching (PSM) estimation and entropy balancing (EB) results, respectively. The dependent variable in all regressions is the annual change in cash levels ($\Delta Cash$). *DevCash* is the difference between target cash holdings and actual cash holdings. *Overconfidence* is an indicator variable measuring CEO overconfidence; it is set to one if *Option Moneyiness* exceeds 67% at least once during the sample period and zero otherwise. *Controls* includes the control variables representing firm (i.e., *Size*, *Tobin's Q*, *Dividend*, *IndSigma*, *CF*, *NWC*, *CAPEX*, *Leverage*, *Research and Development [R&D]*, *Acquisition*, *Age*, *Return*, *Return Volatility*), CEO (*Tenure*, *Ownership*, *Gender*, *Age*, *Vega*, *Delta*), and board characteristics (*Independent Directors*, *Female Directors*), as per Eq. (1). ***, **, and * denotes a statistically significant difference at the 1%, 5%, and 10% levels, respectively. Standard errors robust to clustering by industry using the two-digit SIC industry classification are reported in parentheses.

	KORUS FTA		CEO Turnover	Matching Estimation	
	Overconfidence = 1	Overconfidence = 0		PSM	Entropy Bal.
	(1)	(2)	(3)	(4)	(5)
DevCash*HighTariff*PostFTA	0.060*** (0.023)	-0.031 (0.038)			
DevCash*Treatment*PostTurnover			0.189*** (0.019)		
DevCash*Overconfidence				0.023** (0.011)	
DevCash*Overconfidence					0.020** (0.009)
Constant	0.024*** (0.009)	0.005 (0.012)	0.002 (0.026)	-0.028 (0.019)	-0.004 (0.016)
Controls	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects (FE)	Yes	Yes	Yes	Yes	Yes
Industry FE	No	No	Yes	Yes	Yes
Observations	11,884	5,594	4,253	9,702	17,478
Adj. R^2	0.262	0.258	0.205	0.262	0.170

Table 5. Robustness tests: Alternative CEO overconfidence measures

This table presents the results of the robustness tests using alternative CEO overconfidence measures. Panel A (B) reports the results from Eq. (3), including year and industry (year and firm) fixed effects (FE). *Alternative Measure* includes six alternative CEO overconfidence constructs: *Resid_Invest* and *Capex_Invest* (investment-based measures), *CEO_Cont*, *Holder67* and *High_Conf* (option-based measures), and *CEO_Composite*. The dependent variable in all regressions is the annual change in cash levels (*ΔCash*). *DevCash* is the difference between target cash holdings and actual cash holdings. The *Controls* vector includes the control variables representing firm (i.e., *Size*, *Tobin's Q*, *Dividend*, *IndSigma*, *CF*, *NWC*, *CAPEX*, *Leverage*, *Research and Development [R&D]*, *Acquisition*, *Age*, *Return*, *Return Volatility*), CEO (*Tenure*, *Ownership*, *Gender*, *Age*, *Vega*, *Delta*), and board characteristics (*Independent Directors*, *Female Directors*), as per Eq. (1). ***, **, and * denotes a statistically significant difference at the 1%, 5%, and 10% levels, respectively. Standard errors robust to clustering by industry using the two-digit SIC industry classification are reported in parentheses.

Panel A: Year and Industry FE						
	CEO Investment-Based Measures		CEO Option-Based Measures			CEO Composite Measure
	<i>Resid_Invest</i>	<i>Capex_Invest</i>	<i>CEO_Cont</i>	<i>Holder67</i>	<i>High_Conf</i>	<i>CEO_Composite</i>
	(1)	(2)	(3)	(4)	(5)	(6)
DevCash	0.172*** (0.005)	0.168*** (0.006)	0.176*** (0.005)	0.175*** (0.006)	0.176*** (0.005)	0.143*** (0.006)
Alternative Measure	0.033*** (0.001)	0.001 (0.001)	0.001** (0.000)	0.003** (0.001)	0.004*** (0.001)	0.000 (0.001)
DevCash*Alternative Measure	0.027*** (0.008)	0.040*** (0.008)	0.012*** (0.003)	0.018** (0.008)	0.041*** (0.009)	0.083*** (0.008)
Constant	-0.027* (0.016)	-0.006 (0.016)	-0.007 (0.016)	-0.007 (0.016)	-0.007 (0.016)	-0.005 (0.016)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	17,478	17,478	17,478	17,478	17,478	17,478
Adj. R^2	0.304	0.264	0.263	0.263	0.264	0.267
Panel B: Year and Firm FE						
	CEO Investment-Based Measures		CEO Option-Based Measures			CEO Composite Measure
	<i>Resid_Invest</i>	<i>Capex_Invest</i>	<i>CEO_Cont</i>	<i>Holder67</i>	<i>High_Conf</i>	<i>CEO_Composite</i>
	(7)	(8)	(9)	(10)	(11)	(12)
DevCash	0.158*** (0.005)	0.153*** (0.005)	0.161*** (0.005)	0.161*** (0.006)	0.160*** (0.005)	0.127*** (0.006)
Alternative Measure	0.032*** (0.001)	-0.001 (0.001)	0.001** (0.000)	0.003** (0.001)	0.004*** (0.001)	-0.000 (0.001)
DevCash*Alternative Measure	0.025*** (0.008)	0.039*** (0.008)	0.012*** (0.003)	0.015* (0.008)	0.042*** (0.009)	0.086*** (0.008)
Constant	0.010 (0.007)	0.019** (0.007)	0.018** (0.007)	0.017** (0.007)	0.018** (0.007)	0.018** (0.007)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	17,478	17,478	17,478	17,478	17,478	17,478
Adj. R^2	0.297	0.257	0.257	0.256	0.257	0.261

Table 6. Robustness tests: Alternative estimation methods

This table presents the second-step estimation results of the speed of adjustment (SOA) of cash holdings using the ordinary least squares (OLS; regressions (1), (3), and (5)) and fixed effects (FE; regressions (2), (4), and (6)) models. In the first-step estimation to obtain the optimal cash holdings, we used first differences generalized method of moments (GMM; regressions (1) and (2)), system GMM (regressions (3) and (4)), and Driscoll–Kraay (regressions (5) and (6)). *DevCash* is the difference between target cash holdings and actual cash holdings. *Overconfidence* is an indicator variable measuring CEO overconfidence; it is set to one if *Option Money* exceeds 67% at least once during the sample period and zero otherwise. The *Controls* vector includes the control variables representing firm (i.e., *Size*, *Tobin's Q*, *Dividend*, *IndSigma*, *CF*, *NWC*, *CAPEX*, *Leverage*, *Research and Development [R&D]*, *Acquisition*, *Age*, *Return*, *Return Volatility*), CEO (*Tenure*, *Ownership*, *Gender*, *Age*, *Vega*, *Delta*), and board characteristics (*Independent Directors*, *Female Directors*), as per Eq. (1). ***, **, and * denotes a statistically significant difference at the 1%, 5%, and 10% levels, respectively. Standard errors robust to clustering by firm are reported in parentheses.

First-Step Estimation Method	First Differences GMM		System GMM		Driscoll–Kraay	
Second-Step Estimation Method	OLS	FE	OLS	FE	OLS	FE
	(1)	(2)	(3)	(4)	(5)	(6)
DevCash	0.436*** (0.016)	0.409*** (0.016)	0.453*** (0.018)	0.422*** (0.018)	0.730*** (0.028)	0.677*** (0.028)
Overconfidence	0.004** (0.002)	0.004** (0.002)	0.000 (0.001)	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)
DevCash*Overconfidence	0.037** (0.017)	0.034* (0.017)	0.046** (0.021)	0.042** (0.021)	0.100*** (0.032)	0.103*** (0.032)
Constant	0.035** (0.016)	0.055*** (0.007)	-0.006 (0.016)	0.015** (0.007)	0.016 (0.016)	0.031*** (0.007)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	No	Yes	No	Yes	No
Firm FE	No	Yes	No	Yes	No	Yes
Observations	17,478	17,478	17,478	17,478	17,478	17,478
Adj. R^2	0.269	0.259	0.268	0.258	0.272	0.262

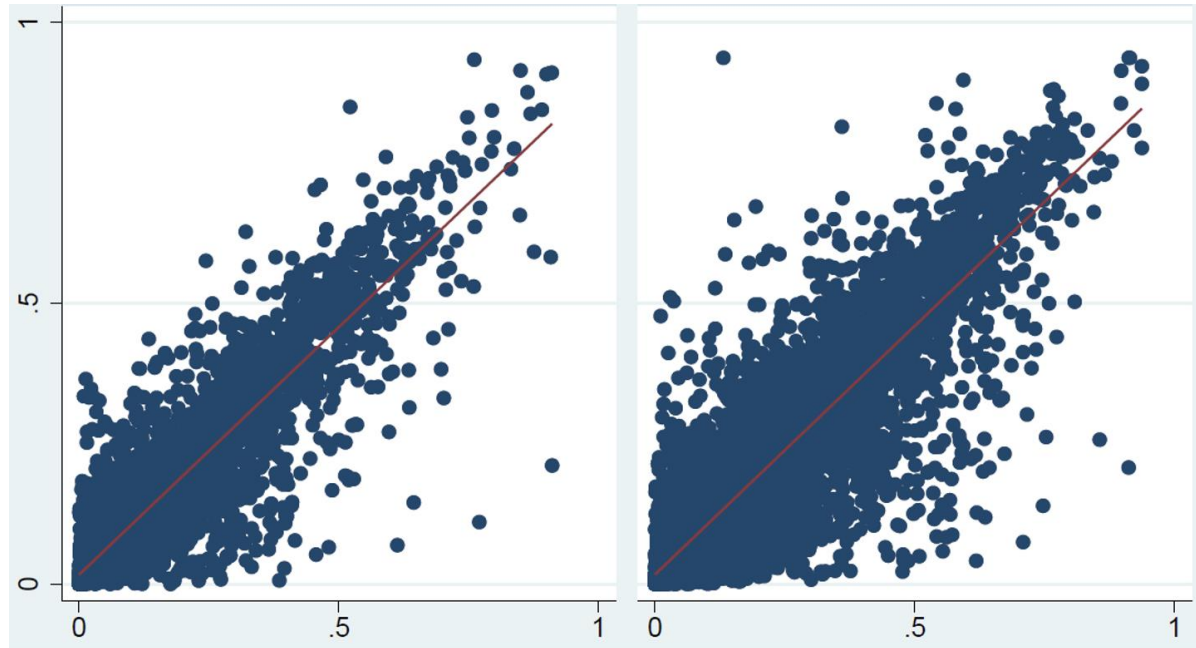
Table 7. Effects of financial constraints, debt levels, and governance quality

This table presents the ordinary least squares (OLS) regressions of CEO overconfidence on the speed of adjustment (SOA) for the cash ratio in the subsamples of firm-year observations according to their financial constraint status, level of debt ratios, and governance quality. The dependent variable is the annual change in cash. *DevCash* is the difference between target cash holdings and actual cash holdings. *Overconfidence* is an indicator variable measuring CEO overconfidence; it is set to one if *Option Moneyness* exceeds 67% at least once during the sample period and zero otherwise. *Controls* includes the control variables representing firm (i.e., *Size*, *Tobin's Q*, *Dividend*, *IndSigma*, *CF*, *NWC*, *CAPEX*, *Leverage*, *Research and Development [R&D]*, *Acquisition*, *Age*, *Return*, *Return Volatility*), CEO (*Tenure*, *Ownership*, *Gender*, *Age*, *Vega*, *Delta*), and board characteristics (*Independent Directors*, *Female Directors*), as per Eq. (1). Panel A presents the regressions of CEO overconfidence on the SOA for the cash ratio after controlling for the financial constraint effect. For each year, for regressions (1) to (4), we define internally financially constrained firms as those that do not make a dividend payment, while externally financially constrained firms are defined as those firms without a credit rating. Panel B presents the regressions of CEO overconfidence on the SOA for the cash ratio after controlling for the debt level in the firm. Regression (5) is based on the subsample of firms with debt below the sample median ratio whereas Regression (6) is based on the subsample of firms with debt above the sample median ratio. *CreditRisk* is an indicator variable that equals one if the interest coverage ratio (earnings before interest and tax [EBIT] divided by interest expenses) for firm *i* in year *t* is lower than 2 and zero otherwise. Panel C presents the regressions of CEO overconfidence on the SOA for the cash ratio after controlling for the quality of the firm's governance. Regression (7) (8) includes the subsample of firm-year observations with good (bad) corporate governance. We define the quality of corporate governance by the CEO duality indicator variable *Duality*, where duality is assumed to reflect a bad corporate governance practice. *CEO duality* is one if the CEO of the firm is also the chair of the board and zero otherwise. Year and industry fixed effects (FE) are included in all regressions. ***, **, and * denotes a statistically significant difference at the 1%, 5%, and 10% levels, respectively. Standard errors robust to clustering by firm are reported in parentheses.

	Panel A: Financial Constraints (FC)				Panel B: Debt Level		Panel C: Governance Quality	
	Internal FC		External FC					
	Constrained	Unconstrained	Constrained	Unconstrained	Lower	Higher	Bad	Good
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DevCash	0.180*** (0.012)	0.171*** (0.009)	0.174*** (0.009)	0.174*** (0.015)	0.166*** (0.010)	0.221*** (0.013)	0.200*** (0.012)	0.161*** (0.009)
Overconfidence	0.004* (0.002)	-0.000 (0.001)	0.002 (0.001)	0.000 (0.002)	0.002 (0.002)	0.001 (0.002)	-0.001 (0.002)	0.003** (0.002)
DevCash*Overconfidence	0.029** (0.014)	0.010 (0.011)	0.023** (0.010)	0.016 (0.017)	0.002 (0.012)	0.016 (0.015)	-0.032** (0.014)	0.051*** (0.011)
CreditRisk					-0.007 (0.004)	-0.006** (0.003)		
DevCash*CreditRisk					-0.080*** (0.028)	-0.019 (0.024)		
Overconfidence*CreditRisk					-0.008 (0.006)	0.005 (0.003)		
DevCash*Overconfidence*CreditRisk					0.157*** (0.035)	0.010 (0.030)		
Constant	0.013 (0.076)	0.009 (0.016)	-0.006 (0.022)	-0.022 (0.022)	0.011 (0.024)	-0.039* (0.022)	-0.002 (0.022)	-0.005 (0.024)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,554	9,924	12,549	4,929	8,739	8,739	7,625	9,853
Adj. R^2	0.301	0.253	0.284	0.226	0.308	0.282	0.243	0.291

Figure 1. Distribution of cash holdings ratios

This figure shows the distribution of cash holdings ratios for the subsamples of non-overconfident (A) and overconfident CEOs (B). The vertical and horizontal axes relate to cash holdings at time t and time $t-1$, respectively. Each dot represents the values of the cash holdings ratio for each pair of firm-year observations measured in t and $t-1$, while the solid line represents the fitted values of the observations.

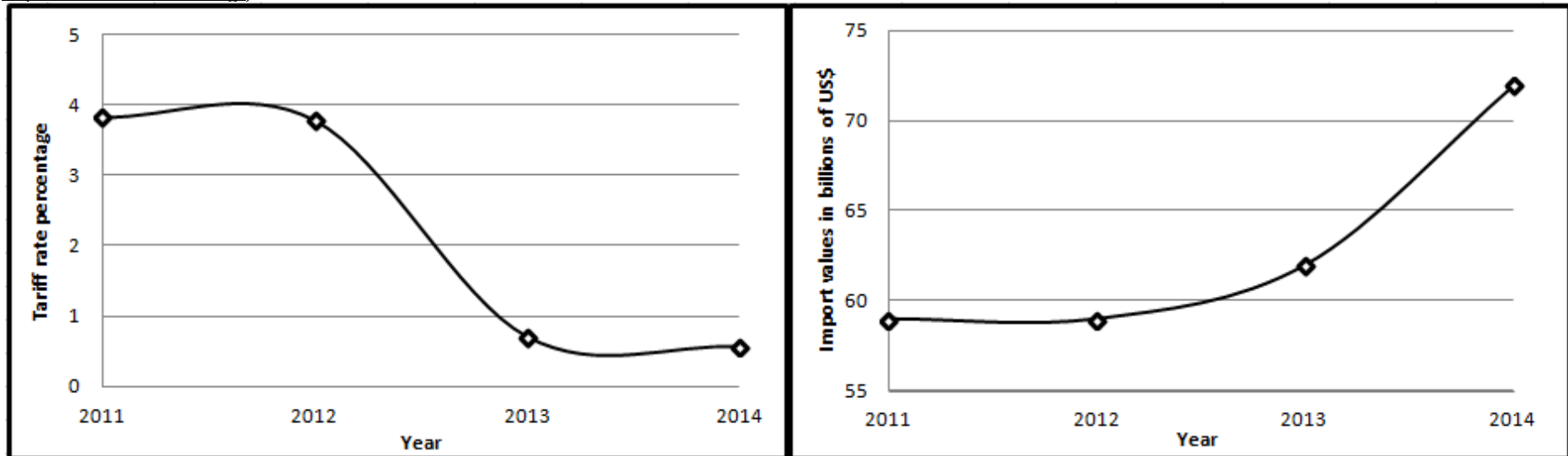


A: Sub-sample with non-overconfident CEOs

B: Subsample with overconfident CEOs

Figure 2. Tariff on and value of Korean imports

In this figure, A shows the overall average percentage tariff on Korean imports to the US between 2011 and 2014 for all industries. The x-axis represents the year, whereas the y-axis represents the tariff rate percentage. In addition, B shows the aggregate values of imports across all industries from Korea to the US between 2011 and 2014. The x-axis represents the year, whereas the y-axis represents the import values in billions of US\$ (nominal values). Source: World Integrated Trade Solution (WITS; <https://wits.worldbank.org/>)



A: Overall average tariff (%)

B: Aggregate value of imports across all industries (\$ billion)

Appendix

Table A1. Definition of variables and Compustat data items

Variable	Definition
Cash	Ratio of cash and short-term investments to total assets (CHE/AT).
Target	Target cash holdings level, defined as the predicted value from the annual cross-sectional regressions of Opler et al. (1999) and Bates et al. (2009), which include lagged cash flow, industry cash flow volatility, Tobin's Q, capital expenditures, leverage, dividend indicator variable, firm size, net working capital (excluding cash), R&D expenditures, and expenditures on acquisitions, stock return, stock volatility, and industry median values of cash holdings (with industries classified according to the two-digit SIC codes).
DevCash	Deviation from target cash holding level, which is the difference between this year's fitted cash holdings based on the annual cross-regression model and last year's actual cash holdings.
Size	Firm size calculated as the logarithm of total assets (AT).
NWC	Net working capital ratio ((WCAP-(CH+MSA))/AT).
IndSigma	Industry risk calculated as the 10-year rolling window median volatility of cash flow/assets across the 48 Fama–French industries. See Dittmar and Duchin (2010).
CF	Cash flow ratio calculated as earnings less interest and taxes (IB+DP), divided by total assets (AT). See Dittmar and Duchin (2010).
CAPEX	Capital expenditure divided by total assets (CAPX/AT).
Tobin's Q	The market value of assets, defined as book value of assets (AT) minus book value of equity (CEQ) plus market value of equity (CSHO*PRCC) minus deferred taxes (TXDB) divided by book value of assets (AT). See Kaplan and Zingales (1997).
Leverage	Total debt divided by total assets ((DLTT +DLC) /AT).
Dividend	Indicator variable: one if the firm paid any common dividends in the year and zero otherwise.
R&D	Research and development expenditures over total assets (XRD/AT).
Age	The logarithm of the number of years the firm has been covered by the Compustat database.
Acquisitions	The ratio of expenditures on acquisitions to the book value of total assets (AQC/AT).
Return	The average of firm-specific daily returns over year t .
Return Volatility	The standard deviation of firm-specific daily returns over year t .
MedIndCash	The median value of cash holdings for each industry category using the two-digit SIC codes.
Option Moneyiness	For each CEO-year, we measure the realizable value per option by dividing the total realizable value of the options from ExecuComp (OPT-UNEX-EXER-EST-VAL) by the number of exercisable options (OPT-UNEX-EXER-NUM). We then subtract the per option realizable value from the stock price at the fiscal year-end (PRCC-F) to obtain an estimate of the average exercise price of the options. The average option moneyiness ratio then equals the per option realizable value divided by the average exercise price ((PRCC-F/PRCC-F-(OPT-UNEX-EXER-EST-VAL/OPT-UNEX-EXER-NUM))-1).
Overconfidence	Dummy variable: one if <i>Option Moneyiness</i> defined above exceeds 67% at least once during the sample period and zero otherwise.
Resid_Invest	Dummy variable: one if the residual from the model regressing the asset growth rate on the sales growth rate is greater than zero and zero otherwise.
Capex_Invest	Dummy variable: one if the capital expenditure ratio (capital expenditure in year t divided by total assets in year $t-1$) is larger than the industry median of this ratio and zero otherwise.
CEO_Cont	Average of the CEO's in-the-money options divided by the average strike price (Banerjee et al., 2015).
Holder67	Dummy variable: one for all years following the year when the CEO holds options that are at least 67% in the money and zero otherwise (Hirshleifer et al., 2012).
High_Conf	Dummy variable: one if the CEO holds at least once during his/her tenure options until the year of their expiration, and the stock options' value is greater than or equal to the threshold of the 25 th percentile in-the-money option value of the sample and zero otherwise.
CEO_Composite	Dummy variable: one if the firm satisfies at least two of the following criteria in a given year: i) The firm exhibits excess investment compared to its primary industry, ii) the firm's merger and acquisition activity surpasses the industry median, iii) the firm's debt-to-equity ratio exceeds the industry median, and iv) the firm utilizes convertible debt or preferred stocks; zero otherwise.
CEO Tenure	The number of years the CEO has been in position.
CEO Ownership	The fraction of total shares outstanding owned by the CEO.
CEO Gender	Dummy variable: one if the CEO is male and zero otherwise.
CEO Age	The age of the CEO measured in years.
CEO Vega	Change in the dollar value of the CEO's wealth for a 0.01 change in the annualized standard deviation of stock returns (measured in thousands of dollars). The data from 1996 to 2018 are provided by Lalitha Naveen and constructed as per her paper (Coles et al., 2006). Data for 2019 and 2020 are our own construction, following Coles et al. (2006) and Core and Guay (2002).

Table A1. (continued)

CEO Delta	Change in the dollar value of the CEO's wealth for a 1% change in stock price (measured in thousands of dollars). The data from 1996 to 2018 are provided by Lalitha Naveen and constructed as per Coles et al. (2006). Data for 2019 and 2020 are our own calculations, following Coles et al. (2006) and Core and Guay (2002).
Independent Directors	The number of outside directors on the board scaled by the board size.
Female Directors	The number of female directors on the board scaled by the board size.
Duality	Dummy variable: one if the CEO is also the chair of the firm and zero otherwise.
Internal FC	Dummy variable: one if the firm does not pay dividends (internally financially constrained) and zero otherwise (internally financially unconstrained).
External FC	Dummy variable: one if the firm does not have any S&P domestic long-term issuer credit rating (externally financially constrained) and zero otherwise (externally financially unconstrained).
CreditRisk	Dummy variable: one if the interest coverage ratio is lower than two and zero otherwise. Interest coverage ratio is earnings before interest and tax (EBIT) divided by interest expenses (XINT).

Table A2. Detailed descriptive statistics

This table reports the detailed summary statistics on firms and CEO characteristics. The sample consists of 17,478 firm-year observations for the period 1996–2020. All nonbinary variables are winsorized at the 1st and 99th percentiles. Table A1 defines the variables.

	Mean	SD	Min	p25	Median	p75	Max
CEO Overconfidence Measures							
Overconfidence	0.680	0.467	0	0	1	1	1
Resid_Invest	0.384	0.486	0	0	0	1	1
Capex_Invest	0.486	0.500	0	0	0	1	1
CEO_Composite	0.557	0.497	0	0	1	1	1
CEO_Cont	0.654	1.159	0	0	0.233	0.808	8.897
Holder67	0.570	0.495	0	0	1	1	1
High_Conf	0.216	0.411	0	0	0	0	1
Firm Characteristics Measures							
Cash	0.152	0.161	0.0001	0.032	0.094	0.220	0.937
Size (\$ million)	7951	24292	21	701	1810	5400	551669
Tobin's Q	2.128	1.368	0.593	1.296	1.714	2.454	11.340
Dividend	0.580	0.494	0	0	1	1	1
IndSigma	0.224	0.555	0.010	0.051	0.087	0.141	11.794
CF	0.092	0.096	-1.272	0.061	0.096	0.137	0.334
NWC	0.116	0.159	-0.530	0.009	0.101	0.207	0.693
CAPEX	0.049	0.048	0	0.020	0.035	0.062	0.558
Leverage	0.221	0.174	0	0.065	0.213	0.332	0.807
R&D	0.033	0.055	0	0	0.006	0.045	0.680
Acquisitions	0.032	0.064	-0.003	0	0.002	0.030	0.348
Age (years)	29.336	16.984	2	15	25	43	71
Return	0.000	0.007	-0.562	0.000	0.001	0.001	0.014
Return Volatility	0.081	0.110	0.017	0.025	0.035	0.081	0.965
Internal FC	0.432	0.495	0	0	0	1	1
External FC	0.718	0.450	0	0	1	1	1
CreditRisk	0.131	0.338	0	0	0	0	1
CEO and Board Characteristics Measures							
CEO Tenure (years)	8.682	7.631	1	3	6	12	62
CEO Ownership	0.018	0.038	0	0.001	0.003	0.011	0.179
CEO Gender	0.969	0.174	0	1	1	1	1
CEO Age	56.176	7.295	20	51	56	61	96
CEO Vega (\$ thousands)	123.26	207.54	0	2.034	44.524	144.35	1225.8
CEO Delta (\$ thousands)	633.72	1511	0	56.141	187.11	552.86	12121
Independent Directors	0.675	0.250	0	0.6	0.75	0.857	1
Female Directors	0.131	0.112	0	0	0.125	0.2	1
Duality	0.436	0.496	0	0	0	1	1

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