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Finance Working Paper N° 663/2020
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Abstract

We examine the links between CEO overconfidence, the speed of adjustment (SOA) of cash holdings, and firm value for listed US firms. First, we find that the SOA is value-relevant above and beyond the cash holdings level. Second and more importantly, we find a positive effect of CEO overconfidence on the SOA. We address endogeneity concerns through a difference-in-differences approach, propensity score matching, and entropy balancing. Our results are robust to the use of alternative estimation methods. Finally, we find that financial constraints, debt levels, 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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1. Introduction

This paper investigates whether and how CEO overconfidence affects the speed of adjustment (SOA) of cash holdings for listed non-financial 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 the *SOA*. Why would the SOA of cash holdings matter? Graham and Harvey's (2001) survey of US chief financial officers (CFOs) reveals that managers 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 reflected by a lower cost of financing and higher firm value. Similarly, we find that the SOA matters as it is value relevant above and beyond the level of cash holdings. Importantly. our results reveal that firms managed by overconfident managers have a faster SOA. In comparison, non-overconfident CEOs spend an additional seven to nine months to adjust their cash holdings toward their optimal level.

Returning to the cash holdings levels, capital market imperfections create an association between the cash holdings level and firm value (Gao et al., 2013). Put differently, there exists an optimal cash holdings level that maximizes firm value. Further, Opler et al. (1999) show that managers do not let cash holdings rise too high or drop too low, 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, and 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.

However, empirical research suggests various factors that reduce the speed at which firms move toward their optimal cash holdings levels (Dittmar and Duchin, 2010). Such 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, in the presence of financial constraints, firms subject to greater information asymmetry 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). 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.[1]

While the above studies 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, such as decisions about investments (Malmendier and Tate, 2005), financing (Malmendier et al., 2011), mergers and acquisitions (Malmendier and Tate, 2008), 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.

Why would CEO overconfidence affect the SOA of cash holdings? We argue that CEO overconfidence accelerates the SOA toward the firm's optimal cash level. Similar to Deshmukh et al. (2021), we expect overconfident CEOs to perceive their firm's equity to be underpriced. Hence, such CEOs rely more heavily on internal cash to finance current investments and delay raising external financing. This results in a higher SOA. This is our first testable hypothesis.

[1] Nikolov and Whited (2014) find that agency problems, on average, lead to cash holdings exceeding their optimal level, hence 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). Similarly, Jiang and Lie (2016) find that entrenched managers keep cash holdings at a higher than optimal level.

Importantly, we study whether CEO overconfidence and the SOA of cash holdings are value relevant. While the level of cash holdings has been shown to be value relevant, this not only confirms the existence of an optimal level of cash holdings, but it also suggests that the SOA toward achieving the optimal level must be value relevant as well. Therefore, we posit that there is a positive link between the SOA toward the optimal cash holdings level and firm value. This is our second testable hypothesis.

Our findings support the validity of the above two hypotheses. First, we find that 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 the SOA is positive. In detail, it takes about seven 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, managerial overconfidence and the SOA are value relevant. While the value relevance of CEO overconfidence confirms Aktas et al. (2019), who focus on the value of cash holdings and overconfidence, our finding that the SOA is value relevant for firms with overconfident CEOs is novel.

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 environment. The difference-in-differences 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 non-linear effects of the control variables on the SOA of cash holdings. Therefore, we use two matching estimations, namely propensity score matching (PSM) and entropy balancing (EB). We are able to confirm our main findings.

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 the positive impact of CEO

overconfidence on the SOA to be more pronounced for financially constrained firms. Besides, when we divide our sample into two sub-samples according to the level of debt, 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 it matters as the positive effect of CEO overconfidence on the SOA is more pronounced for firms with better corporate governance quality. Finally, to check the robustness of our results, we re-estimate the optimal cash holdings level for each firm using alternative estimation methods, namely the first differences generalized method of moments (GMM), system-GMM, and the Driscoll Kraay specification. All these robustness tests confirm our main findings.

Our paper provides strong evidence that managerial overconfidence increases the SOA of cash holdings. By doing so, our paper 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 the SOA is novel. Importantly, our paper suggests that the SOA is value relevant in the presence of an overconfident CEO. We establish this association by using the SOA as an explanatory variable in our regression analysis; we are not aware of any other paper that has done likewise.

Second, our paper adds to the behavioral finance literature. 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 study 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 the speed matters above and beyond the cash holdings levels.

The paper proceeds as follows. The next section reviews the literature while Section 3 develops the hypotheses. Section 4 discusses the data sources, the sample construction, and the methodology. It is followed by a section on the summary statistics and the empirical findings. Section 6 performs the identification tests. Section 7 contains the robustness checks while Section 8 conducts additional analyses. Section 9 concludes the paper.

2. Literature Review

2.1. The SOA of cash holdings

Research on the determinants of cash holdings has focused on the cross-sectional dispersion of cash holdings (e.g., Opler et al., 1999; Kim et al., 1998). 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, some (e.g., Ozkan and Ozkan, 2004; Flannery and Rangan, 2006; Jiang and Lie, 2016) 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 literature, i.e., the literature on the SOA of leverage,[2] has identified several costs that affect the SOA of leverage toward the target level. These include the 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).

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

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 firms do not adjust immediately toward their optimal cash level due to the presence of costs, with the SOA ranging from 22% to 43% depending on the estimation method they use. They also find that the SOA is affected by the firm's age and governance mechanisms. In turn, Jiang and Lie (2016) report an SOA of 31%. While 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, hence reducing 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.[3] To conclude, the SOA from the actual cash holdings level toward the target cash holdings level is not immediate as it is affected by various external and internal frictions.

2.2. CEO overconfidence and the SOA

A growing body of literature attempts 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, i.e., greater efficiency in generating revenues, plays a role in the SOA of cash holdings for Korean firms. They find that when the cash holdings exceed their target level, managers with greater ability are more likely to dissipate excess cash compared to 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 that they have superior decision-

[3] 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.

making skills. Managerial overconfidence has been the subject of detailed observation and analysis. For example, Deshmukh et al. (2021) find that firms with overconfident CEOs hold on average 24% less cash. 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 due to their perception that their firm's stock is undervalued by the market. Malmendier et al. (2011) provide support for this argument as they find that overconfident managers issue less equity than their peers. As a consequence, overconfident managers may underinvest if their firm's internal funds are scarce or the access to debt is limited. Finally, Aktas et al. (2019) find further confirmation of this argument. They show that overconfident CEOs increase the value of a $1 cash holding by $0.28. This suggests that additional cash mitigates the underinvestment problem that overconfident CEOs suffer from.

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 about 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 on 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 suffers from overconfidence.

More precisely, we expect overconfident CEOs to increase the SOA. Indeed, since such CEOs perceive their firm's equity to be underpriced, they delay raising external financing and rely more heavily on internal cash. Hence, CEO overconfidence affects the speed at which the firm adjusts its cash holdings, with firms with overconfident CEOs having a greater SOA.

Nevertheless, one may still expect variation in the SOA among firms with overconfident CEOs. Such variation would be caused by some firms having cash holdings exceeding their optimal level and others having cash holdings below that level. Given asymmetric information and the resulting adverse selection costs (Myers and Majluf, 1984), managers prefer internal financing, i.e., cash, over external financing. 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 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 (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. Therefore, we expect overconfident managers to increase their cash spending, thereby accelerating the SOA toward the firm's optimal cash holdings level. A similar argumentation is advanced by Deshmuk et al. (2013) whose theoretical model predicts that overconfident managers consider external borrowing to be expensive, reduce cash dividends payment and then accumulate cash to finance future investments. This discussion leads us to our first hypothesis, which is as follows:

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

3.2. The value relevance of the SOA

With the absence of frictions in the capital markets and shocks, such as economic crises, a firm's cash holdings level should be at its optimal level or revert virtually instantaneously to the optimal level if it has been pushed off that level. This would imply a very high SOA as per the static version of the trade-off theory of cash holdings.[4] However, given frictions and

[4] Using the trade-off theory, Do et al. (2022) find empirical evidence of the value relevance of SOA of leverage for US firms, noting that cash holdings and leverage decisions 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 in turn is associated with higher firm value (see e.g., Bates et al., 2018 and Gao et al., 2013).

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.

Why would the SOA be value relevant? First, a slow SOA coupled with a cash holdings level below the optimal level may force the firm to forego valuable, i.e., positive-NPV projects. Second, a slow SOA combined with a cash holdings level that exceeds the optimal level may cause investors to be concerned about the management potentially misspending the cash on empire building, including value-destroying acquisitions and other negative-NPV projects.

In both cases, managers should be motivated to adopt a high SOA to maximize the value of their firm. Similarly, the findings in Faulkender and Wang (2006) imply that deviations from the optimal cash holdings level due to a relatively low SOA reduce the value of the firm. Finally, Sun et al. (2021) show that cash holdings policies of US firms constitute an important aspect of financial risk management to enhance firm value. Therefore, we posit the following hypothesis:

H2. *There is a positive association between the SOA and firm value and performance*.

4. Data and Methodology

4.1. Sample selection

Our initial sample of firms is drawn from Compustat and is based on all US firms listed on AMEX, NYSE, and NASDAQ with available data. To avoid any survivorship bias, we include both active and inactive firms. Following the literature, we eliminate observations for financial firms (SIC codes 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 CRSP, IRRC/RiskMetrics, and ExecuComp databases for data on stock returns, director characteristics, managerial overconfidence, and CEO characteristics, respectively. To construct the CEO overconfidence measure we use the Campbell et al. (2011)

modified version of the Malmendier and Tate (2005) measure. Hence, we limit our sample to firms with available CEO options data. All non-binary variables are winsorized at the 1st and 99th percentiles to reduce the potential effects of outliers. Our final sample consists of 17,541 firm-year observations across 1,486 firms between 1996 (i.e., the first year with data available from IRRC/Risk Metrics) to 2020.

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 and hence 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 CEOs that hold exercisable options that are deep in the money.

The dataset used by Malmendier and Tate (2005) to construct their CEO option-based measure is a comprehensive but proprietary dataset. Yet, 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 the 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 and 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 H1

The estimation of the SOA of cash holdings is 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.

following line with the existing literature, we employ a two-step estimation procedure. Note that we use the ratio of cash and short-term investments to total assets in what follows. The first step consists of estimating the target cash holdings ratio. In the second step, we use this estimated target cash holdings ratio in the estimation of a partial adjustment model of the firm's rebalancing decisions while controlling for the possible presence of CEO overconfidence. This model is particularly suitable for our analysis as it allows for estimating the SOA in the presence of interactive effects (Jiang and Lie, 2016).

The simplest method for estimating the 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 the Fama-Macbeth method using cross-sectional regressions to estimate Eq. (1) below.[5]

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

where *Cash* represents the cash holdings ratio for firm *i* in year *t*. *X* is a vector of firm and industry characteristics. Our choice of variables coincides with Opler et al. (1999) and Bates et al. (2009). We include the following variables: firm size, net working capital, industry cash flow risk, cash flows, capital expenditures, Tobin's Q, leverage ratio, the 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. Also, we include both the stock return and stock volatility as control variables. Finally, we add additional variables representing CEO and board of directors characteristics, i.e., CEO tenure, CEO ownership, CEO gender, CEO age, and the ratios of independent directors and female directors.

Some studies on capital structure (e.g., Cook and Tang, 2010; Devos et al., 2017) also include the main variable of interest when estimating target leverage to check whether the results change compared to those obtained from a regression excluding this variable. Hence, we include our variable of interest (*Overconfidence*) along with the interactions of this variable with each of the control variables in Eq. (1) to estimate the target cash holdings ratio. The reason for including the main variable of interest and its interactions with the control variables

[5] In the robustness section, we use two alternative methods to estimate the target cash holdings ratio. First, we re-estimate the dynamic panel data regressions using the system generalized method of moments (GMM) employing both equations in levels and in first differences, and the first-differenced GMM employing only first-differenced equations. Second, we re-estimate 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.

in the first-step regression is that overconfident CEOs may have a different view about what constitutes the target cash ratio than investors (see also Section 3). Including the variable of interest and its interactions with the control variables 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 ($Cash_{i,t} - Cash_{i,t-1}$); and $DevCash_{i,t}$ 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.

Moreover, 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. The distance between the observations and their fitted values for the sub-sample of overconfident CEOs is much greater (see Figure 1B), 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 sub-sample of overconfident CEOs. In contrast, firms with non-overconfident CEOs tend to be more consistent when it comes to the level of their cash holdings (see Figure 1A).

<INSERT Figure 1 HERE>

In order to examine further 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; and *Overconfidence* is the CEO overconfidence measure. Our focus is on the coefficient on the interaction term (i.e., β_3). A negative (positive) sign for this coefficient indicates that CEO overconfidence decreases (increases) the SOA of cash holdings. A positive sign would provide support for H1. 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. Firm Value – Testing the validity of H2

In order to test the effect of the SOA of cash holdings on firm value, we run the following regression:

$$Firm\,Value_{i,t} = \alpha_1 + \beta_1 SOA_{i,t} + \beta_2 Overconfidence_{i,t} + \beta_3 SOA_i * Overconfidence_{i,t} + \beta X_{i,t} + \varepsilon_{i,t} \quad (4)$$

We obtain the SOA ($SOA_{i,t}$) for each firm-year in our sample by estimating Eq. (2) separately for each firm again, bearing in mind that firms may employ different CEOs during the sample time period. $Firm\,Value_{i,t}$ is measured by two variables, namely *Tobin's Q* and *Return on Assets* (*ROA*). $X_{i,t}$ is a vector of control variables that are found to affect a firm's value, namely cash, size, net working capital, leverage, acquisitions, age, stock return, stock volatility, sales growth, CEO Tenure, CEO ownership, CEO gender, CEO age, the independent director ratio, and the female director ratio. All variables are defined in the Appendix.

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 four columns report the mean and median values for the firm-year observations corresponding to overconfident and non-overconfident CEOs. We assign firm-year observations to the overconfident (non-overconfident) sub-sample if the *Overconfidence* indicator variable equals one (zero). This indicator variable is set to one if option moneyness exceeds 67% at least once during the sample period, and zero otherwise.

Out of the 17,541 firm-year observations, we have 11,917 (5,624) firm-year observations with overconfident (non-overconfident) CEOs. The table suggests that the sub-sample of overconfident CEOs is on average more likely to have a higher cash ratio, a higher cash flow, and greater R&D expenditures compared to the sub-sample of non-overconfident CEOs. In addition, firms with overconfident CEOs are smaller, have a lower propensity to pay dividends, and have a higher Tobin's Q, a higher industry sigma, and lower leverage than firms with non-overconfident CEOs. The sub-sample of overconfident CEOs is characterized by CEOs with a longer tenure, firms with more independent directors, and fewer female directors.

<INSERT TABLE 1 HERE>

5.2. Estimation of the partial adjustment model

Table 2 presents the results for the pooled cross-sectional 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 two regressions include year fixed effects only, the second two regressions include both year and industry fixed effects, while the last two include both year and firm fixed effects. Regressions (1), (3), and (5) include the control variables only

whereas regressions (2), (4), and (6) include the controls as well as the interactions between *Overconfidence* and each of the control variables.

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. The coefficients on *Overconfidence* in regressions (1) and (3) are negative and significant. This suggests a significantly negative effect of CEO overconfidence on the cash holdings level when excluding the interaction terms while including year and industry fixed effects. However, this association does not hold when including the interactions between the CEO overconfidence indicator variable, *Overconfidence*, and the control variables. Also, this association is not robust when including year and firm fixed effects. 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 are in contrast with the findings of Chen et al. (2020) who report a positive association between CEO overconfidence and the cash holdings ratio.

<INSERT TABLE 2 HERE>

Table 3 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) without including the CEO overconfidence measure and its interactions with the control variables in the regression (based on regression (3) of Table 2), whereas regressions (3) and (4) are estimated using the target cash ratio from Eq. (1) including the variable *Overconfidence* and the interactions between *Overconfidence* and each control variable (based on regression (4) of Table 2).

In regression (1) of Table 3, the coefficient on the deviation from the optimal cash ratio is 0.174, suggesting that the SOA is 17.4%. Further, the coefficient on the deviation from regression (3) is 0.168, which indicates that the SOA is 16.8%. These values are similar to Dittmar and Duchin (2010) who find an SOA of 22%.

We now focus on the effect of CEO overconfidence on the SOA. The main variable of interest is the interaction term between *DevCash* and *Overconfidence*. In all the regressions, the interaction term *DevCash* Overconfidence* has a statistically significant (at the 5% level or better) coefficient with a positive sign. For example, for regression (1), the coefficient of 0.021 suggests that overconfident CEOs increase the SOA as it takes less time for firms with overconfident CEOs to revert to their target cash holdings. The positive effect of CEO overconfidence on the SOA is 12.1% (= 0.021 / 0.174). Hence, it takes firms with overconfident CEOs 7 months less, compared to firms with non-overconfident CEOs, to revert to their target cash holdings.[6]

In regression (3), which includes the CEO overconfidence indicator variable and its interaction terms with the control variables, we still find similar results for the effect of CEO overconfidence on the SOA. The positive effect of CEO overconfidence on the SOA is 13.69% (= 0.023 / 0.168). Therefore, it takes firms with overconfident CEOs nine months less, compared to those with non-overconfident CEOs, to revert to their target cash holdings. These findings support our first hypothesis that CEO overconfidence plays a significant role in increasing the speed at which firms move toward their optimal cash holdings ratios.[7]

<INSERT TABLE 3 HERE>

5.3. Firm value, CEO overconfidence and the SOA of cash holdings

In this section, we study whether firm value is sensitive to differences in the SOA of cash holdings. In other words, we investigate whether the SOA is value relevant and whether it creates value above and beyond the level of the cash ratio, as per hypothesis 2. More

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

[7] As a robustness check, we re-estimate our main regressions using two alternative measures of CEO overconfidence based on Campbell et al. (2011). They are: (i) *Overconfidence_100*, which equals one if the CEO holds exercisable options that are 100% deep in the money at least once during the CEO's tenure period, and zero otherwise; and (ii) *Post*, which equals one in all CEO-years that follow (and including) the year in which the CEO holds options that are more than 67% in the money, and zero otherwise. Our results remain qualitatively the same when using these alternative definitions.

specifically, we aim to examine whether firm value and performance, measured by *Tobin's Q* and *ROA*, respectively, are affected by the firm being managed by an overconfident CEO rather than by a non-overconfident CEO.

The results are reported in Table 4 using Eq. (4). All four regressions suggest that the SOA is value relevant. In detail, for regressions (1) and (3), we find that the coefficient on *SOA* is significant (at the 10% level) and positive. This indicates that the SOA is value relevant and the faster the speed at which the firm moves toward its target ratio the higher is the firm performance and firm value. This result supports our second hypothesis.

Regressions (2) and (4) qualify the above result. Importantly, in addition to *SOA*, regressions (2) and (4) include the interaction between *SOA* and *Overconfidence*. Note that the coefficient on *SOA* is no longer significant. However, the coefficient on the interaction between SOA and *Overconfidence* is significant (at the 5% level or better) and positive in both regressions. This indicates that firm value and performance are significantly higher for firm-year observations with both an overconfident CEO and a higher SOA. Still, *Overconfidence* on its own also has a positive effect on firm value.

We conclude that both CEO overconfidence and the SOA of cash holdings are value relevant. In detail, our results suggest that firms with a higher SOA have a higher value and performance. Further, the positive effect of the SOA on firm value and performance stems mostly from overconfident CEOs.

<INSERT TABLE 4 HERE>

6. Identification Tests

6.1. Difference-in-differences analysis

The concern remains that our estimates might be biased due to endogenous matching of CEO overconfidence and corporate cash holdings decisions. Namely, 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., reverse causality) is rather low, as it is unlikely that CEOs would only consider firms with specific dynamic cash policies when looking for a potential new employer.

As an alternative way of addressing this endogeneity concern, we identify an event causing an exogenous shock to firms' cash holdings. We use the ratification of the 2012 US-Korea Free Trade Agreement (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 USA being phased out.[8] The rationale for choosing this event comes from Morellec et al.'s (2014) and Della Seta's (2011) theoretical model predicting that cash holdings increase with greater competition. Extant literature finds empirical support for this prediction as they observe that competition increases corporate cash holdings. More specifically, several studies use the KORUS FTA and find that it affects firms' cash holdings decisions (Fresard, 2010; Alimov, 2014; and Zhang, 2020).

KORUS FTA became effective from 2013. The trade relations between the USA 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.[9] Therefore, this agreement represents a quasi-natural experiment exploiting the elimination of tariffs between both countries across a large number of different industries. From an individual firm's perspective, the agreement constitutes an exogenous and unanticipated shock to the firm's competitive environment. Therefore, it makes sense to use this setting to assess the impact of

[8] The time it took to phase out the tariffs depended on the product category. There were 11 product categories with times to phase out tariffs 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.

[9] For a further discussion on the validity of FTAs as an exogenous shock, see Guadalupe and Wulf (2010) and Alimov (2014).

CEO overconfidence on the SOA of cash holdings. The tariff data is sourced from World Integrated Trade Solution (WITS).[10]

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 USA. Imports amounted to less than $60 billion in both 2011 and 2012, and then 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 an exogenous shock to firms' 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 may thus not have been endogenous, this approach ensures that all industries are treated the same. The pre-FTA tariffs (i.e., the 2011 tariffs) at the two-digit SIC industry level ranged from zero to 10.37%. We define high tariff industries as those that are in the top tercile of the pre-FTA tariffs (above 2%), whereas low tariff industries are those 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 actual and optimal cash holdings compared to those with low tariffs.

[10] 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/).

Via a difference-in-differences 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 due to a reduction in tariffs and those with a lower increase (second difference). We do this for the two sub-samples 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. (5) below for the sub-sample of firm-year observations with overconfident CEOs and the sub-sample of firm-year observations with non-overconfident CEOs.

$$\Delta \text{Cash}_{i,t} = \alpha_1 + \beta_1 DevCash_{i,t} + \beta_2 HighTariff_{i,t} + \beta_3 PostFTA_{i,t} + \beta_4 DevCash_{i,t} * PostFTA_{i,t} + \beta_5 DevCash_{i,t} * HighTariff_{i,t} + \beta_6 PostFTA_{i,t} * HighTariff_{i,t} + \beta_7 DevCash_{i,t} * PostFTA_{i,t} * HighTariff_{i,t} + \varepsilon_{i,t} \quad (5)$$

Table 5 provides the results. Based on regressions (1) and (2), for the sub-samples of overconfident and non-overconfident CEOs, the coefficient estimates for *DevCash* suggest an SOA of 18.9% and 17.8%, respectively. Our focus is on the triple interaction term *DevCash*PostFTA*HighTariff*. This term 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 to those that experience relatively small tariff reductions. Regression (1) reveals a positive and significant (at the 10% level) coefficient on the interaction term for the sub-sample of firm-year observations with overconfident CEOs. In contrast, the coefficient on the same interaction term is not statistically significant for the sub-sample of firm-year observations with non-overconfident CEOs in regression (2). These findings imply that, following this exogenous shock, overconfident CEOs of firms with larger

tariff reductions after the FTA is implemented tend to increase the SOA of cash holdings. These results further support our main finding (i.e., evidence in favor of hypothesis 1) that CEO overconfidence increases the SOA.

<INSERT TABLE 5 HERE>

6.2. Matching Estimations

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 pick up non-linear effects of the control variables on the SOA of cash holdings. To address this concern, we create two sub-samples of firm-year observations that are comparable across all the control variables but differ only in terms of whether the CEO is overconfident or not. To do so, we implement two matching methods, namely propensity score matching (PSM) and entropy balancing.

First, we carry out the PSM by matching firm-year observations with overconfident CEOs with firm-year observations with similar characteristics but without overconfident CEOs. Specifically, we run a logistic regression to estimate the propensity scores, $p(Y=1|X=x)$, based on the probability of receiving a binary treatment, Y, conditional on all the control variables, 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 independent variables are the same as those used in regression (1) of Table 3.

The first three columns of Table 6 present the results from the PSM. Regression (1) reports the results for the pre-match logistic regression, i.e., the results for the logit with the determinants of CEO overconfidence, with the dependent variable being *Overconfidence*. We

find that *Size*, *Tobin's Q*, *IndSigma*, *CF*, *Acquisitions*, *CAPEX*, *Return*, *CEO Tenure*, and *Independent Directors* are positively related to *Overconfidence*. In contrast, *Dividend*, *R&D*, *Ln Age*, and *Female Directors* are negatively related to *Overconfidence*.

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 based on the nearest-neighbor method, more specifically 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 0.01%. If there is more than one firm-year observation for overconfident CEOs that meets this criterion, 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 score of treated and controls, thus satisfying the common support condition (Caliendo and Kopeinig, 2008). We obtain 4,121 pairs of matched firm-year observations.

To test for the validity of the conditional independence assumption, we re-estimate 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). Regression (2) shows the results using the post-match sample. 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. These results indicate that, by using PSM, we successfully remove the differences in the observable characteristics other than the difference in the presence of CEO overconfidence.

Next, using the matched sample, we re-run our main regression as per Eq. (3) to verify whether the relationship in question still holds. As per regression (3) in Table 6, the interaction between the firm's deviation of cash (*DevCash*) and the CEO overconfidence measure (*Overconfidence*) is significant (at the 5% level) and positive. This finding is qualitatively similar to the findings reported in Table 3. It provides further support to hypothesis 1.

Following Hainmueller (2012) and Chapman et al. (2019), we also employ entropy balancing to control for 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. The literature does not agree as to how the estimation of the propensity score is best conducted (Imai et al., 2008). Therefore, 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 a guarantee of finding such a satisfactory solution. Further, it is argued that matching may counteract the reduction in the bias for the subsequent treatment effect estimation as improving the balance on some variables decreases the balance on the other variables (Diamond and Sekhon, 2006; Ho et al., 2007; and Iacus et al., 2009).

To overcome these issues, Hainmueller (2012) proposes the use of entropy balancing, which directly incorporates variable balance in the estimation procedure, making the need to check variable balance repeatedly redundant. The results obtained from regression (4) of Table 6 confirm our main results. We conclude that the results obtained from applying PSM and entropy balancing provide further support to hypothesis 1, while mitigating the concern about self-selection bias.

<INSERT TABLE 6 HERE>

7. Robustness Tests

Given that a reliable estimation of the target cash holdings ratio is vital for our study, we conduct two robustness tests using alternative methods to estimate the optimal cash holdings

ratio for each firm. In the first robustness check, we employ two dynamic panel data estimation techniques, namely the Blundell and Bond (1998) system GMM and the Arellano and Bond (1991) first differences GMM. 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. (6) below to estimate the optimal cash holdings ratios.

$$\text{Cash}_{i,t} = (1 - \lambda)Cash_{i,t-1} + \gamma_n \sum_1^n Control\ variables + \varepsilon_{i,t} \quad (6)$$

In the second step, and similar to the main analysis, we include the estimated values in Eq. (3) to estimate the firm's SOA of cash holdings.

The second robustness test consists of using 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 to correct for the presence of cross-sectional correlation. In the second step, we include this estimated value using the Driscoll and Kraay estimator in Eq. (2) to estimate the firm's SOA of cash holdings.

Table 7 reports the results from employing these alternative estimation techniques. The results are similar to our previous findings: We still 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. The first differences GMM estimation yields an SOA of 32.6% (regression (1)). The system GMM estimation yields a comparable SOA of 31.2% (regression (3)). Finally, the Driscoll and Kray estimation generates and SOA of 39.3% (regression (5)).

<INSERT TABLE 7 HERE>

8. Additional Analyses

This section discusses the impact of financial constraints, the level of debt finance, and corporate governance on the relation between the 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, i.e., 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. As overconfident CEOs believe external financing to be 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, hence increasing the SOA of cash holdings.[11] To sum up, 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 negatively affect the value of cash holdings, suggesting overinvestment.

In order to examine how CEO overconfidence affects the SOA of cash holdings in the presence of financial constraints, we re-estimate Eq. (3) after dividing our sample into financially constrained and unconstrained firm-year observations. Following the existing

[11] 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).

literature (Almeida et al., 2004; Farre-Mensa and Ljungqvist, 2016; Aktas et al., 2019), 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 to the internally financially constrained sub-sample if it does not pay a dividend. For the externally financially constrained firms, we use the absence of credit ratings as a proxy for financial constraints (Aktas et al., 2019). More specifically, for each year, we define externally financially constrained firms as those without a credit rating.[12] We expect the interaction between *DevCas*h and *Overconfidence* to be significant and more positive for financially constrained firms because such firms would be expected to have a faster SOA.

The constraints measure in the first two columns of Table 8 is based on internal financial constraints proxied by the absence of dividend payments. In regression (1) for the financially constrained firms, the coefficient on the interaction term is significantly positive while it is not significant in regression (2) for the unconstrained firms. For the former, the size of this coefficient (0.028) suggests that the effect is economically significant as CEO overconfidence increases the SOA by 15.22% (= 0.028/0.184). Namely, it takes about nine months less for overconfident CEOs of financially constrained firms to move toward their target cash holdings. Compared with our findings in Table 3 where CEO overconfidence increases the SOA by 12.1%, the existence of financial constraints further speeds up this adjustment process.

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 as CEO overconfidence increases the SOA by

[12] The definition of each financial constraint proxy is reported in the Appendix.

11.8% (= 0.021/0.178). All in all, 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 8 HERE>

8.2.The role of debt

Another factor that may affect the SOA of cash holdings is the 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 the firm's debt level and the SOA of cash holdings could be explained by the following 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 liquidity. Given this substitutability between cash holdings and debt (Strebulaev and Yang, 2013), the SOA of cash holdings is expected to be lower with high levels of debt (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 whether, after controlling for different levels of debt, CEO overconfidence still affects the SOA. We attempt to answer this question by dividing our sample into two sub-samples according to whether the leverage ratio is below or above the sample median.

Furthermore, 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 reserves. Similarly, the literature on debt

structure highlights the importance of credit risk and information asymmetry for the firm's debt decisions (e.g., Bali and Skinner, 2006; Hackbarth et al., 2006; Daniels et al., 2010). For example, the survey by Graham and Harvey (2001) shows that managers care the most about the firm's credit ratings and financial flexibility when making debt issuance decisions. One would expect that, especially when debt is high, controlling for credit risk is important. Therefore, we include a measure of credit risk, *CreditRisk*, and interact it with *DevCash*Overconfidence* in both sub-samples of high and 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. (7) below to test for a differential SOA for firms with high debt levels compared to those with low debt levels while considering the firms' credit risk:

$$\Delta\text{Cash}_{i,t} = \alpha_1 + \beta_1 DevCash_{i,t} + \beta_2 Overconfidence_{i,t} + \beta_3\, DevCash_{i,t} * Overconfidence_{i,t} + \beta_4\, CreditRisk_{i,t} + \beta_5 DevCash_{i,t} * CreditRisk_{i,t} + \beta_6 Overconfidence_{i,t} * CreditRisk_{i,t} + \beta_7 DevCash_{i,t} * Overconfidence_{i,t} * CreditRisk_{i,t} + \varepsilon_{i,t} \quad (7)$$

Regressions (5) and (6) of Table 8 suggest that the SOA is higher for firm-year observations with an above median debt level (22.5%) compared to firm-year observations with a below median debt level (16.7%). This suggests that above median levels of debt reflect reduce 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).

Further, 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 0.153. The speed at which

overconfident CEOs of firms with high and low credit risk adjust their cash holdings is given by $\lambda = \beta_1 + \beta_3 + \beta_5 + \beta_7$ and $\lambda = \beta_1 + \beta_3$, respectively. Hence, the SOA for firms with overconfident CEOs and high credit risk is 24.6% (= 0.167 + 0.005 – 0.079 + 0.153), whereas the SOA for firms with overconfident CEOs and low credit risk is only 17.2% (=0.167 + 0.005). Therefore, there is some evidence that CEO overconfidence in the below average debt level sub-sample 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 the firm's 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 8 HERE>

8.3.Corporate governance quality

According to 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 corporate 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 re-estimate Eq. (3) by considering the quality of the firm's governance. To this end, we divide our sample into sub-samples of firm-year observations with good and bad corporate 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 corporate 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 corporate governance because these firms are expected to have a faster SOA.

The results are provided in regressions (7) and (8) of Table 8. Regression (8) for the sub-sample of firm-year observations with good governance (i.e., without duality) shows that 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 29.70% (= 0.049/0.165). Namely, it takes about seventeen 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 14.71% (= 0.03/0.204). Therefore, it takes about eight months longer for overconfident CEOs working in firms with bad governance to move toward their target cash holdings. Compared with our findings in Table 4 where CEO overconfidence increases the SOA by 12.1%, good governance further speeds up this adjustment process.

<INSERT TABLE 8 HERE>

9. Conclusion

The cash holdings literature has examined the association between managerial overconfidence and cash holdings levels as well as the incremental value of holding additional cash. However, it has not studied the relevance of the overconfidence of the top executives for the SOA of cash holdings levels. Our study fills this gap. The key finding of this study is that CEO overconfidence plays a significant role in affecting the SOA of cash holdings of listed US firms. We find that overconfident CEOs increase the speed at which their firm adjusts toward its target cash ratio: Firms managed by overconfident CEOs take on average seven to nine

months less to adjust toward their target cash holdings ratio than firms managed by non-overconfident CEOs.

Our findings suggest that if the actual cash holdings deviate from their target level, overconfident CEOs increase the SOA. Importantly, we find that the combination of CEO overconfidence and a higher SOA of cash holdings improve firm performance and firm value. Further, our sub-sample analyses suggest that this positive effect of CEO overconfidence on the 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 do our best to address various endogeneity concerns, namely reverse causality, unobserved heterogeneity, and dynamic endogeneity. To this end, we implement a difference-in-differences analysis using the 2012 US-Korea Free Trade Agreement as an exogenous shock and propensity score matching to match firm-year observations with overconfident CEOs with firm-year observations with non-overconfident CEOs using firm characteristics. In addition, we use entropy balancing to avoid any bias inherent in PSM. Our results remain robust. In addition, our findings are also robust to using various alternative definitions of the target cash holdings ratio, alternative measures for CEO overconfidence, and the inclusion of controls for the quality of the firm's governance.

Overall, our study highlights the importance of CEO overconfidence for the SOA of cash holdings, as well as showing that this adjustment speed is value relevant.

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Table 1. Descriptive statistics

Table 1 displays summary statistics on firm characteristics for the entire sample as well as the sub-samples of firm-year observations corresponding to overconfident and non-overconfident CEOs. See the Appendix for the variable definitions. The sample consists of 17,541 firm-year observations for the period 1996-2020. The *t*-tests (Wilcoxon-Mann-Whitney *z*-tests) are conducted to test for differences in means (medians) between firm-year observations with overconfident and non-overconfident CEOs. All non-binary variables are winsorized at the 1st and 99th percentiles. ***, **, and * denotes a statistically significant difference at the 1%, 5%, and 10% level, respectively.

	Entire Sample		**Overconfidence = 1**		**Overconfidence = 0**	
	Mean	Median	Mean	Median	Mean	Median
Overconfidence	0.679	1				
Cash	0.153	0.094	0.156	0.096	0.145***	0.092***
Size ($ millions)	7954	1806	7177	1770	9597***	1903***
Tobin's Q	2.131	1.714	2.271	1.835	1.833***	1.506***
Dividend	0.579	1	0.550	1	0.641***	1***
IndSigma	0.087	0.224	0.236	0.089	0.197***	0.079***
CF	0.096	0.092	0.098	0.102	0.080***	0.086***
NWC	0.1	0.116	0.118	0.105	0.110***	0.091***
CAPEX	0.035	0.05	0.050	0.036	0.047***	0.033***
Leverage	0.221	0.213	0.214	0.204	0.236***	0.226***
R&D	0.033	0.006	0.035	0.007	0.028***	0.004***
Acquisitions	0.032	0.002	0.034	0.003	0.027***	0.001***
Ln Age	3.242	3.258	3.202	3.219	3.327***	3.367***
Return	0.0002	0.0005	0	0.001	0	0
Return volatility	0.081	0.035	0.081	0.081	0.080	0.034***
CEO Tenure	8.672	6	9.774	8	6.340***	4***
CEO Ownership	0.018	0.003	0.018	0.004	0.018	0.002***
CEO Gender	0.968	1	0.974	1	0.957***	1***
CEO Age	56.165	56	56.184	56	56.135	56
Independent Directors	0.674	0.75	0.685	0.75	0.653***	0.75
Female Directors	0.131	0.125	0.124	0.111	0.148***	0.125***
No. of observations	17,541	17,541	11,917	11,917	5,624	5,624

Table 2. Determinants of cash holdings ratio

Table 2 reports the determinants of the optimal level of cash holdings. The dependent variable is the cash ratio (Cash). Control variables include the firm, CEO, and board of directors characteristics as per Eq. (1). Regressions (1), (3) and (5) include the main control variables only whereas regressions (2), (4) and (6) include the control variables as well as the interaction terms between *Overconfidence* and each of these control variables. See the Appendix for the definitions of the variables. Year-, industry-, and firm-fixed effects are controlled for in the regressions as indicated. The significance levels of 10%, 5%, and 1% are represented by *, **, ***, respectively. Standard errors robust to clustering by firms are reported in parentheses.

	Year FE		Year & Industry FE		Year & Firm FE	
	(1)	(2)	(3)	(4)	(5)	(6)
Overconfidence	-0.012***	-0.010	-0.012***	-0.005	-0.003	-0.022
	(0.002)	(0.024)	(0.002)	(0.023)	(0.004)	(0.022)
Size * Overconfidence		0.002		0.002		-0.000
		(0.002)		(0.002)		(0.001)
Tobin's Q * Overconfidence		-0.004**		-0.004**		-0.007***
		(0.002)		(0.002)		(0.001)
Dividend * Overconfidence		-0.012***		-0.015***		-0.005
		(0.005)		(0.004)		(0.004)
IndSigma * Overconfidence		-0.006*		-0.003		0.002
		(0.004)		(0.004)		(0.003)
CF * Overconfidence		0.017		0.022		0.035**
		(0.023)		(0.022)		(0.017)
NWC * Overconfidence		0.082***		0.075***		0.054***
		(0.013)		(0.013)		(0.011)
CAPEX * Overconfidence		-0.013		-0.035		-0.037
		(0.043)		(0.042)		(0.035)
Leverage * Overconfidence		0.002		0.018		0.008
		(0.012)		(0.012)		(0.010)
R&D * Overconfidence		-0.133***		-0.121***		-0.016
		(0.043)		(0.042)		(0.036)
Acquisition * Overconfidence		-0.058*		-0.067**		-0.029
		(0.031)		(0.030)		(0.022)
Age * Overconfidence		-0.013***		-0.014***		-0.005
		(0.004)		(0.004)		(0.003)
Return * Overconfidence		-0.035		0.054		0.265
		(0.278)		(0.268)		(0.213)
Return Volatility * Overconfidence		-0.009		-0.017		0.012
		(0.018)		(0.018)		(0.018)
CEO Tenure * Overconfidence		0.000		0.000		-0.001**
		(0.000)		(0.000)		(0.000)
CEO Ownership * Overconfidence		-0.247***		-0.196***		-0.097
		(0.058)		(0.057)		(0.059)
CEO Gender * Overconfidence		0.029***		0.035***		0.015
		(0.010)		(0.010)		(0.009)
Independent Directors * Overconfidence		-0.000		-0.000		0.000
		(0.000)		(0.000)		(0.000)
Females Directors * Overconfidence		0.004		0.009		0.011**
		(0.007)		(0.007)		(0.005)
Size	-0.005***	-0.007***	-0.005***	-0.006***	-0.019***	-0.018***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.002)
Tobin's Q	0.022***	0.026***	0.023***	0.027***	0.012***	0.018***
	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)
Dividend	-0.025***	-0.018***	-0.024***	-0.014***	-0.009**	-0.006
	(0.002)	(0.004)	(0.002)	(0.004)	(0.004)	(0.004)
IndSigma	-0.004**	0.001	-0.000	0.002	0.001	-0.000
	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.002)
CF	-0.033***	-0.043**	-0.048***	-0.061***	-0.031**	-0.056***
	(0.011)	(0.018)	(0.011)	(0.018)	(0.016)	(0.014)
NWC	0.143***	0.086***	0.188***	0.135***	0.185***	0.147***
	(0.006)	(0.011)	(0.007)	(0.011)	(0.021)	(0.010)
CAPEX	-0.368***	-0.356***	-0.489***	-0.462***	-0.463***	-0.436***
	(0.021)	(0.037)	(0.024)	(0.038)	(0.036)	(0.033)
Leverage	-0.168***	-0.171***	-0.144***	-0.156***	-0.073***	-0.079***
	(0.006)	(0.010)	(0.006)	(0.010)	(0.012)	(0.009)
R&D	0.986***	1.081***	0.853***	0.938***	0.174***	0.193***
	(0.019)	(0.037)	(0.021)	(0.037)	(0.053)	(0.038)
Acquisition	-0.301***	-0.255***	-0.288***	-0.235***	-0.204***	-0.182***
	(0.014)	(0.027)	(0.014)	(0.026)	(0.011)	(0.018)
Age	-0.021***	-0.013***	-0.020***	-0.011***	-0.034***	-0.030***
	(0.002)	(0.003)	(0.002)	(0.003)	(0.005)	(0.004)
Return	0.053	0.081	-0.068	-0.050	0.153**	0.057
	(0.123)	(0.143)	(0.118)	(0.137)	(0.068)	(0.129)
Return volatility	-0.049***	-0.044***	-0.051***	-0.040***	-0.095***	-0.101***
	(0.009)	(0.015)	(0.009)	(0.014)	(0.025)	(0.025)
CEO Tenure	0.000***	0.000*	0.000**	0.000	0.000	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
CEO Ownership	0.143***	0.274***	0.151***	0.249***	0.010	0.051
	(0.028)	(0.047)	(0.027)	(0.046)	(0.052)	(0.047)
CEO Gender	-0.032***	-0.047***	-0.021***	-0.040***	-0.007	-0.015**
	(0.005)	(0.008)	(0.005)	(0.008)	(0.007)	(0.007)

Table 2 (continued)

CEO Age	-0.000***	-0.001**	-0.000***	-0.000**	-0.001**	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Independent Directors	0.022***	0.020**	0.026***	0.020**	0.021**	0.015**
	(0.007)	(0.009)	(0.007)	(0.008)	(0.009)	(0.007)
Female Directors	-0.019**	-0.035**	-0.018*	-0.025	-0.015	-0.043***
	(0.010)	(0.016)	(0.010)	(0.016)	(0.014)	(0.014)
Constant	0.253***	0.253***	0.211***	0.215***	0.386***	0.380***
	(0.013)	(0.013)	(0.029)	(0.029)	(0.030)	(0.016)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	No	No	Yes	Yes	No	No
Firm FE	No	No	No	No	Yes	Yes
Observations	17,541	17,541	17,541	17,541	17,541	17,541
Adj. R^2	0.470	0.474	0.515	0.519		
Wald Chi^2					1574.75	4511

Table 3. The effect of CEO overconfidence on the speed of adjustment of cash holdings

Table 3 presents the OLS regressions of CEO overconfidence on the adjustment speed for the cash ratios. The dependent variable is the annual change in the cash ratio (ΔCash). *DevCash* is the difference between target cash holdings and actual cash holdings. *Overconfidence* is an indicator variable, measuring CEO overconfidence and 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, CEO and board characteristics as per Eq. (1) as well as the interaction terms between *Overconfidence* and each of the control variables. Year and industry fixed effects are included in all the regressions. The significance levels of 10%, 5%, and 1% are represented by *, **, ***, respectively. Standard errors robust to clustering by firms are reported in the parentheses.

	Without Overconfidence interactions		With Overconfidence interactions	
	(1)	(2)	(3)	(4)
DevCash	0.174***	0.160***	0.168***	0.154***
	(0.007)	(0.007)	(0.007)	(0.007)
Overconfidence	0.017	0.014	0.018	0.015
	(0.013)	(0.013)	(0.013)	(0.013)
DevCash * Overconfidence	0.021**	0.019**	0.023***	0.021**
	(0.009)	(0.009)	(0.009)	(0.009)
Constant	-0.018	0.008	-0.016	0.010
	(0.019)	(0.011)	(0.019)	(0.011)
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	No	Yes	No
Firm FE	No	Yes	No	Yes
Observations	17,541	17,541	17,539	17,539
Adj. R^2	0.268		0.263	
Wald Chi^2		6020.75		5903.62

Table 4. Firm value and performance and the speed of adjustment of cash holdings

Table 4 presents the OLS regressions based on Eq. (4) where the dependent variable is firm value as measured by *Tobin's Q* and firm performance as measured by *Return on Assets (ROA)*, respectively. *SOA* is computed for each firm by estimating Eq. (2). *Overconfidence* is an indicator variable, measuring CEO overconfidence and it is set to one if *Option moneyness* exceeds 67% at least once during the sample period, and zero otherwise. *Cash* is cash and short-term investments to total assets. The dependent variable is Tobin's Q (ROA) for regressions (1) and (2) ((3) and (4)). *Controls* includes the control variables representing firm, CEO and board characteristics as per Eq. (1). Year and industry fixed effects are included in all the regressions. The significance levels of 10%, 5%, and 1% are represented by *, **, ***, respectively. Standard errors robust to clustering by firms are reported in parentheses.

	Firm Value - Tobin's Q		**Firm Performance - ROA**	
	(1)	(2)	(3)	(4)
SOA	0.021*	-0.029	0.001*	-0.001
	(0.011)	(0.018)	(0.001)	(0.001)
Overconfidence		0.370***		0.023***
		(0.028)		(0.002)
SOA * Overconfidence		0.077***		0.004**
		(0.023)		(0.002)
Cash	2.738***	2.734***	-0.018***	-0.017***
	(0.071)	(0.071)	(0.006)	(0.006)
Constant	1.931***	1.854***	-0.029	-0.072***
	(0.287)	(0.300)	(0.022)	(0.023)
Controls	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Observations	17,525	17,517	17,525	17,517
Adj. R^2	0.268	0.287	0.132	0.142

Table 5. Difference-in-differences analysis

Table 5 presents the difference-in-differences analysis using the 2012 US-Korea Free Trade Agreement as an exogenous shock. The dependent variable is the annual change in cash levels (ΔCash). *DevCash* is the difference between target cash holdings and actual cash holdings. *HighTariff* is an indicator variable that equals one if the firm experiences tariff reductions following the FTA in excess of 2.5% (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. *Overconfidence* is an indicator variable, measuring CEO overconfidence and it is set to one if *Option moneyness* exceeds 67% at least once during the sample period, and zero otherwise. Year fixed effects are included in all the regressions. The significance levels of 10%, 5%, and 1% are represented by *, **, ***, respectively. Standard errors robust to clustering by industry using the two digits SIC industry classification are reported in parentheses.

	Overconfidence=1	**Overconfidence=0**
	(1)	(2)
DevCash	0.189***	0.178***
	(0.013)	(0.011)
HighTariff	0.000	-0.000
	(0.003)	(0.003)
PostFTA	0.023***	0.032***
	(0.006)	(0.007)
DevCash * PostFTA	-0.037***	-0.042**
	(0.013)	(0.018)
DevCash * HighTariff	0.003	-0.020
	(0.056)	(0.030)
PostFTA * HighTariff	0.003	0.005
	(0.003)	(0.007)
DevCash * HighTariff * PostFTA	0.043*	0.079
	(0.023)	(0.098)
Constant	0.024**	0.003
	(0.010)	(0.013)
Controls	Yes	Yes
Year FE	Yes	Yes
Industry FE	No	No
Observations	11,917	5,624
Adj. R^2	0.259	0.257

Table 6. Propensity score matching and entropy balancing

Table 6 presents the propensity score matching (PSM) estimation and entropy balancing results. Regression (1) reports the pre-match logit regression of the likelihood of the presence of overconfident CEOs. Regression (2) presents the post-match logit regression predicting the probability of having an overconfident CEO. In both regressions (1) and (2) the dependent variable is *Overconfidence*. Regressions (3) is estimated from Eq. (3) using the post-matched sample while regression (4) is estimated using the full sample. 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 and it is set to one if Option moneyness exceeds 67% at least once during the sample period, and zero otherwise. The independent variables represent firm, CEO, and board characteristics as per Eq. (1). Variable definitions are given in the Appendix. Year and industry fixed effects are included in all the regressions. Standard errors robust to clustering by firm are reported in parentheses. Significance levels of 10%, 5%, and 1% are represented by *, **, ***, respectively.

	Propensity Score Matching			Entropy Balancing
	Pre-match logit	Post-match logit	Based on Eq. (3)	Based on Eq. (3)
	(1)	(2)	(3)	(4)
DevCash			0.183***	0.171***
			(0.008)	(0.007)
Overconfidence			0.002	-0.003
			(0.018)	(0.008)
DevCash * Overconfidence			0.026**	0.024***
			(0.012)	(0.009)
Size	0.054***	-0.020	-0.002**	0.000
	(0.016)	(0.042)	(0.001)	(0.000)
Tobin's Q	0.274***	0.023	0.001	0.000**
	(0.019)	(0.038)	(0.001)	(0.000)
Dividend	-0.232***	0.057	0.006**	-0.002***
	(0.041)	(0.103)	(0.002)	(0.001)
IndSigma	0.082**	-0.031	0.000	0.001***
	(0.035)	(0.063)	(0.002)	(0.000)
CF	0.988***	-0.282	-0.000	0.019***
	(0.213)	(0.375)	(0.013)	(0.004)
NWC	0.046	0.039	0.012	-0.002
	(0.127)	(0.297)	(0.007)	(0.002)
CAPEX	0.968**	-0.469	-0.206***	-0.026***
	(0.406)	(0.872)	(0.024)	(0.006)
Leverage	-0.126	0.046	0.041***	0.011***
	(0.114)	(0.288)	(0.007)	(0.002)
R&D	-1.174***	-0.376	0.015	0.005
	(0.395)	(0.969)	(0.024)	(0.007)
Acquisition	1.658***	-0.321	-0.435***	-0.059***
	(0.288)	(0.409)	(0.016)	(0.003)
Age	-0.217***	0.059	-0.001	-0.002**
	(0.034)	(0.090)	(0.002)	(0.001)
Return	12.092***	7.281	0.421	0.993***
	(3.084)	(10.542)	(0.278)	(0.174)
Return volatility	-0.138	0.066	0.006	0.004
	(0.173)	(0.517)	(0.009)	(0.003)
CEO Tenure	0.116***	0.002	-0.000	0.000***
	(0.004)	(0.009)	(0.000)	(0.000)
CEO Ownership	-10.420***	-0.180	0.083**	-0.032***
	(0.575)	(1.668)	(0.036)	(0.010)
CEO Gender	0.171*	-0.210	-0.005	-0.002
	(0.098)	(0.265)	(0.006)	(0.002)
CEO Age	-0.026***	0.006	0.000**	-0.000***
	(0.003)	(0.008)	(0.000)	(0.000)
Independent Directors	0.538***	-0.247**	0.010	0.007***
	(0.069)	(0.120)	(0.006)	(0.002)
Female Directors	-1.336***	-0.129	0.004	-0.007*
	(0.173)	(0.402)	(0.011)	(0.004)
Constant	0.893***	-0.045	-0.020	0.006
	(0.216)	(0.562)	(0.023)	(0.015)
Overconfidence * Control	No	No	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Observations	17,541	8,242	8,232	17,541
Pseudo R^2 (Adj. R^2)	0.100	0.004	0.258	0.247

Table 7. Robustness tests: Alternative estimation methods

The regressions of Table 7 present the second step estimation results of the speed of adjustment of cash holdings using system GMM (regressions (1) and (2)), first differences 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 and 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, CEO and board characteristics as per Eq. (1) as well as the interaction terms between *Overconfidence* and each of the control variables. Year and industry fixed effects are included in all the regressions. The significance levels of 10%, 5%, and 1% are represented by *, **, ***, respectively. Standard errors robust to clustering by firm are reported in parentheses.

	First Differences GMM		System GMM		Driscoll Kraay	
	(1)	(2)	(3)	(4)	(5)	(6)
DevCash	0.326***	0.300***	0.312***	0.287***	0.393***	0.388***
	(0.022)	(0.022)	(0.020)	(0.020)	(0.029)	(0.029)
Overconfidence	0.027**	0.024*	0.021	0.019	0.020	0.019
	(0.014)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
DevCash * Overconfidence	0.070***	0.066**	0.058**	0.053**	0.160***	0.160***
	(0.026)	(0.026)	(0.024)	(0.024)	(0.035)	(0.035)
Constant	0.004	0.032***	-0.024	0.007	-0.011	0.017
	(0.019)	(0.012)	(0.019)	(0.012)	(0.019)	(0.012)
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	17,459	17,459	17,459	17,459	17,459	17,459
R^2	0.222		0.223		0.219	

Table 8. The effect of financial constraints, debt levels, and governance quality

Table 8 presents the regressions of CEO overconfidence on the SOA for the cash ratio for the sub-samples of firm-year observations according to their financial constraint's status, the level of the debt ratios, and the 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 and 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, CEO and board of directors characteristics as per Eq. (1) as well as the interaction terms between *Overconfidence* and each of the control variables. 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 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) (6) is based on the sub-sample of firms with debt below (above) the sample median ratio. *CreditRisk* is an indicator variable that equals one if the interest coverage ratio (EBIT divided by interest expenses) for firm *i* in year *t* is lower than 2, and 0 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 sub-sample 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 bad corporate governance. *CEO duality* is one if the CEO of the firm is also the chairman of the board, and zero otherwise. Year and industry fixed effects are included in all regressions. The significance levels of 10%, 5%, and 1% are represented by *, **, ***, respectively. Standard errors robust to clustering by firms 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	0.184***	0.172***	0.178***	0.173***	0.167***	0.225***	0.204***	0.165***
	(0.013)	(0.009)	(0.009)	(0.016)	(0.011)	(0.013)	(0.013)	(0.010)
Overconfidence	0.018	0.007	0.019	-0.020	0.000	0.036**	-0.018	0.028
	(0.025)	(0.019)	(0.017)	(0.025)	(0.020)	(0.018)	(0.022)	(0.017)
DevCash * Overconfidence	0.028**	0.012	0.021**	0.027	0.005	0.014	-0.030**	0.049***
	(0.014)	(0.011)	(0.010)	(0.018)	(0.013)	(0.016)	(0.015)	(0.012)
CreditRisk					-0.010**	-0.007**		
					(0.005)	(0.003)		
DevCash * CreditRisk					-0.079***	-0.011		
					(0.029)	(0.025)		
Overconfidence * CreditRisk					-0.003	0.007*		
					(0.006)	(0.004)		
DevCash * Overconfidence * CreditRisk					0.153***	-0.003		
					(0.035)	(0.030)		
Constant	0.005	0.006	-0.014	-0.006	0.011	-0.064**	0.009	-0.022
	(0.078)	(0.020)	(0.025)	(0.029)	(0.028)	(0.025)	(0.027)	(0.027)
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	7,598	9,943	12,603	4,938	8,768	8,773	7,655	9,891
Adj. R^2	0.302	0.254	0.285	0.228	0.307	0.283	0.246	0.291

Figure 1 Distribution of cash holdings ratios

This figure shows the distribution of cash holdings ratios for the sub-samples of non-overconfident and overconfident CEOs. The vertical axis and horizontal axis 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. Figure 1A focuses on the sub-sample of non-overconfident CEOs while Figure 1B focuses on the sub-sample of overconfident CEOs.

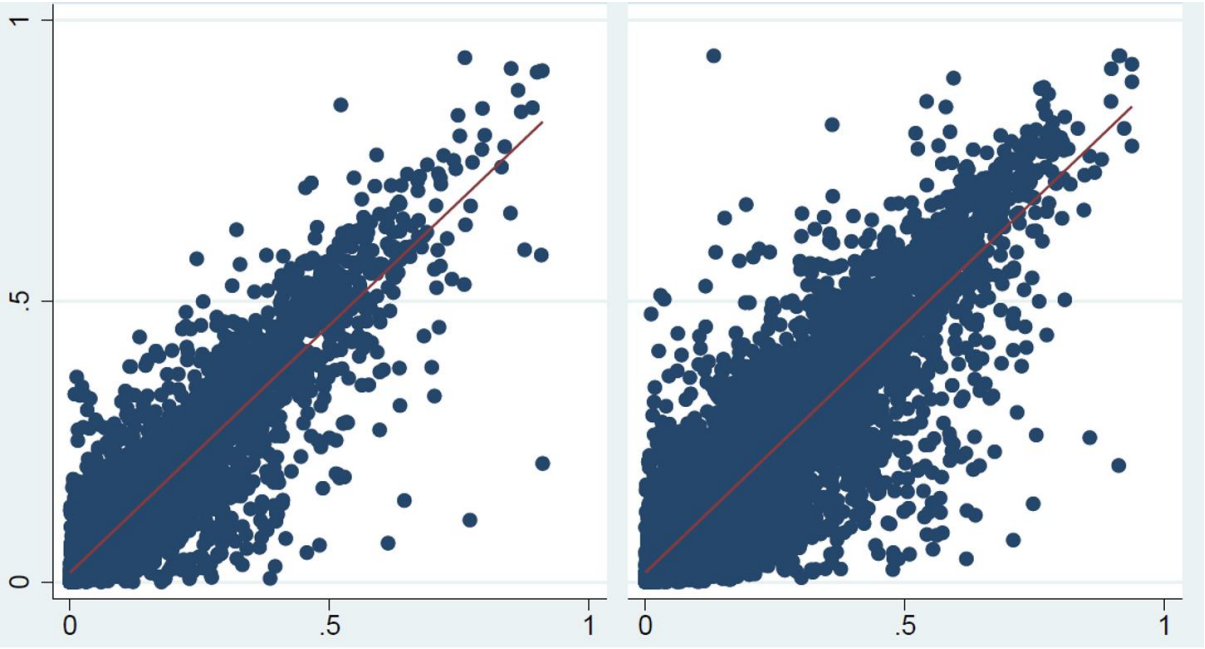

Figure 1A: Sub-sample with non-overconfident CEOs

Figure 1B: Sub-sample with overconfident CEOs

Fitted values Cash ratio

Figure 2 Tariff on and value of Korean imports

Figure 2A shows the overall average percentage tariff on Korean imports to the USA between 2011 and 2014 for all industries. The x-axis represents the year whereas the y-axis represents the tariff rate percentage. Figure 2B shows the aggregate values of imports across all industries from Korea to the USA 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/)

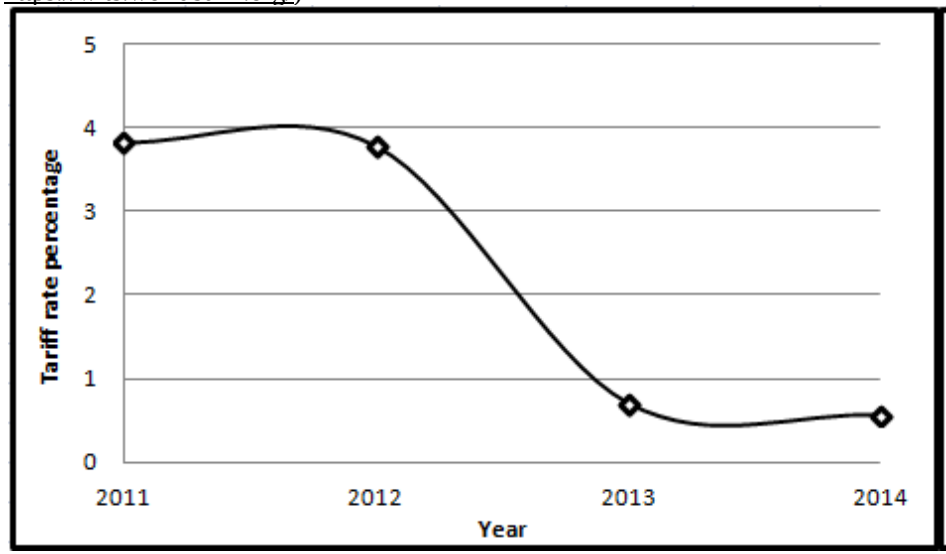

Figure 2A: Overall Average Tariff (%)

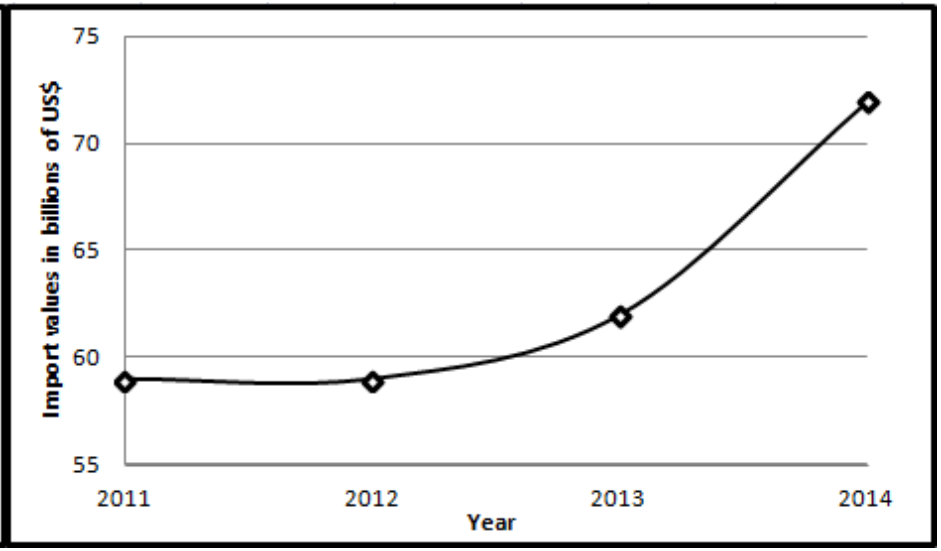

Figure 2B: Aggregate Value of Imports Across All Industries (billion US$)

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 (we classify industries according to the 2-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.
SOA	The speed of adjustment of cash holdings: average SOA per firm, estimated from Eq.(2).
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 ten-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 in the year any common dividends, 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 returnns over year t.
MedIndCash	The median value of cash holdings for each industry category using the 2-digit SIC codes.
Option Moneyness	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 moneyness 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	Indicator variable measuring CEO overconfidence: One if *Option Moneyness* exceeds 67% at least once during the sample period, and 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	Indicator variable: One if the CEO is male, and zero otherwise.
CEO Age	The age of the CEO measured in years.
Independent Directors	The number of outside directors on the board scaled by the board size.
Female Directors	The number of female dirctors on the board scaled by the board size.
Duality	Indicator variable: One if if the CEO is also the chairman of the firm, and zero otherwise.
Internal FC	Indicator variable: One if a firm does not pay dividends (internally financially constrained), and zero otherwise (internally financially unconstrained).
External FC	Indicator variable: One if a firm does not have any S&P domestic long term issuer credit rating (externally financially constrained), and zero otherwise (externally financially unconstrained).
CreditRisk	Indicator variable: One if the interest coverage ratio is lower than two, and zero otherwise. Interest Coverage ratio is defined as earnings before interest and tax (EBIT) divided by the interest expenses (XINT).

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