



Precautionary motive or private benefit motive for holding cash: Evidence from CEO ownership[☆]

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ABSTRACT

This study examines how CEO ownership affects the motivation of firms to hold cash. We document a monotonic and positive relationship between CEO ownership and cash holdings. The effect is more pronounced for firms with higher firm-specific risk and larger external financing costs, suggesting that CEO ownership encourages firms to hold more cash as precautionary savings. However, we find no evidence that CEO ownership leads to cash hoarding in firms with weak corporate governance. Moreover, we show that firms with high CEO ownership and excess cash holdings have more capital expenditures and R&D expenses but do not have higher dividend payments and share repurchases. Nonetheless, shareholders' perceived value of cash increases with CEO ownership, indicating that shareholders place a positive value on high levels of cash holdings associated with CEO ownership in the context of growing investment prospects. Overall, our findings support the notion that firm ownership aligns the interests of CEOs and shareholders, rather than encouraging managers to extract private benefits through hoarding cash.

1. Introduction

The existing literature has provided various explanations for the incentives of firms to hold cash. One of the early explanations is based on the transaction-cost motive for cash holdings (Baumol, 1952; Keynes, 1937; Miller & Orr, 1966), which suggests that firms hold cash to evade the expenses incurred due to the lack of liquid assets. Building on this strand of literature, Opler et al. (1999) propose the precautionary motive, which suggests that firms save cash to hedge the risk of future cash shortfall. Prior studies model the precautionary demand for cash and find that financially constrained firms (Almeida et al., 2004) and firms with riskier cash flows (Han & Qiu, 2007) accumulate higher cash reserves. In particular, when external finance is costly or idiosyncratic risk is high, firms with more investment opportunities hold more precautionary cash (Riddick & Whited, 2009).¹

Another explanation derived from agency theory is that managers tend to accumulate large cash reserves to pursue their private benefits at the expense of shareholders' wealth, such as empire building and perquisite consumption (Jensen, 1986). This argument is further supported by previous studies on corporate governance, which show that managers tend to hoard excessive cash balances in countries with poor shareholder protection (Dittmar et al., 2003), and entrenched managers use excess cash to make value-decreasing acquisition decisions (Harford, 1999). Consequently, cash is worth less when corporate governance is weak (Dittmar & Mahrt-Smith, 2007).

Recent research focuses on incorporating the role of managerial characteristics in the motives for cash holding. For example, studies have shown that CEO traits, such as risk incentives (Liu & Mau, 2011; Tong, 2010), inside debt (Liu et al., 2014), and overconfidence and

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¹ A recent work by Foley et al. (2007) documents that multinational firms have taxation incentives for holding higher levels of cash. They find that firms with repatriating foreign earnings are more likely to accumulate cash. To test whether firms increase their cash holdings by avoiding repatriation taxes on foreign income, we use our sample firms with non-missing foreign pretax income. Consistent with Bates et al. (2009), we find no evidence that firms with more foreign pretax income hold more cash in our sample. Specifically, the average cash ratio is 14.7% for firms with high foreign taxable income and 17.7% for firms with low foreign taxable income. The difference between the two average cash ratios is statistically significant at the 1% level (t-statistic 14.93).

optimism (Chen et al., 2020; Deshmukh et al., 2021; Huang-Meier et al., 2016), are associated with corporate cash holdings. However, less attention has been paid to examining how managerial ownership affects cash holdings. Jensen and Meckling (1976) and Jensen (1986) argue that managerial ownership can align the interests of managers and shareholders and mitigate managers' incentives to hold large cash reserves. While the agency theory suggests a negative relationship between managerial ownership and cash holdings, prior studies provide ambiguous evidence. Ozkan and Ozkan (2004) find that the relationship between managerial ownership and cash holding is negative when managerial ownership is low, and it turns positive when managerial ownership is high. Conversely, the effect of managerial ownership on cash holdings is negative again when managerial ownership reaches the cubic level.²

On the contrary, Opler et al. (1999) find an inverted U-shaped relationship between managerial ownership and cash holdings. Harford et al. (2008) show an insignificant relationship between managerial ownership and cash holdings for low levels of managerial ownership, but a positive association between the two for high levels of managerial ownership. Chen (2008) and Chen and Chuang (2009) argue that shareholders accept high levels of cash reserves for firms with great investment opportunities when low levels of CEO ownership serve as efficient corporate governance.

Given the conflicting evidence documented in the previous empirical studies, it is difficult to draw a conclusion on how managerial ownership affects corporate cash holdings. The existing literature does not offer a clear proposition regarding the role of CEO ownership in firms' motives for holding cash. To fill the gap in the literature, we examine how managerial ownership affects corporate cash management and whether there exists a non-monotonic relationship between managerial ownership and cash holdings. Specifically, we investigate how the precautionary motive and the private benefit motive drive the relationship between CEO ownership and cash holdings.³

On the one hand, external financing costs increase with information asymmetry between firms and outside investors, leading to an underinvestment problem. Cash holdings as precautionary savings can mitigate the underinvestment problem and enhance firm value, especially when future cash flows are volatile. Firm ownership provides CEOs incentives to take actions that benefit both shareholders and themselves. Therefore, we expect a positive relationship between CEO ownership and corporate cash holdings. On the other hand, agency theory argues that managerial ownership can mitigate entrenched managerial behaviors, such as squandering cash on perquisite consumption and empire building. As such, we expect the impact of CEO ownership on cash holdings should be negative. However, previous studies also argue that the impact of CEO ownership on cash holdings could be non-linear. As the level of managerial ownership rises, external shareholders may have reduced capacity to oversee managers, potentially leading to a higher degree of managerial control and entrenchment (Morck et al., 1988; Opler et al., 1999; Ozkan & Ozkan, 2004). Consequently, at higher levels of managerial ownership, managers may choose to accumulate more cash to pursue their private interests, resulting in a positive relationship.

To test whether CEO ownership has a precautionary incentive alignment effect or a non-linear effect driven by private benefit motive

² In Ozkan and Ozkan's (2004) empirical analyses, managerial ownership is the total percentage of equity ownership held by company directors.

³ In this study, we only compare the precautionary motive to the private benefit motive. However, previous studies suggest that firms may hold cash for various reasons. As discussed in Bates et al. (2009), we anticipate that the relationship between CEO ownership and cash holdings is less susceptible to other motives for holding cash, such as the transaction cost motive. Foley et al. (2007) also find that firms with repatriating foreign earnings are more likely to accumulate cash. However, we find no evidence to support this taxation motive in our sample.

on cash holdings, we analyze a sample of Standard & Poor's (S&P) 1500 firms from 1992 to 2018. Our findings suggest that on average, CEO ownership is associated with a 3.7% to 4.2% increase in cash holdings. We find no evidence of a non-monotonic relationship between ownership and cash holdings in our sample. Additionally, we find that CEOs play a dominant role in corporate cash policy within a top management team.

Our results are robust to a variety of identification methods, additional controls, and alternative measures. We also investigate the mechanisms through which CEO ownership affects cash holdings and find that CEO ownership has a stronger positive impact on cash holdings when firms have higher firm-specific risk and larger external financing costs. This finding indicates that in the presence of higher firm risks and external financing costs, CEO ownership acts as an incentive for firms to maintain a higher cash reserve to meet precautionary demands.

Moreover, we find no evidence that the positive relationship between CEO ownership and cash holdings is stronger among firms with weaker corporate governance, which supports the baseline outcomes. If CEO ownership results in the entrenchment of managerial behaviors, then CEOs are more likely to hoard cash reserves in the absence of effective corporate governance. In addition, we show that firms with high CEO ownership and excess cash holdings have more capital expenditures and R&D expenses, but do not have higher dividend payments and share repurchases. Meanwhile, shareholders' perceived value of cash increases with CEO ownership. Taken together, these findings imply that CEO ownership acts as a precautionary incentive alignment effect by saving cash for investment opportunities and increasing firm value.

We contribute to the growing literature on cash holdings by resolving the ambiguity in how CEO ownership affects the incentives of firms to hold cash and examining how shareholders evaluate CEOs' motives for holding cash. The precautionary motive proposes that CEO ownership functions as a precautionary incentive alignment effect, aligning the interests of managers and shareholders by meeting the precautionary cash needs of firms. The private benefit motive suggests that the agency problem of cash accumulation is reduced at low levels of CEO ownership, whereas at high levels, it encourages managerial entrenchment in cash management, resulting in a non-linear effect of CEO ownership on cash holdings. Our study provides strong evidence to support the precautionary motive in which CEO ownership has an incentive alignment effect. Our findings show that shareholders place a positive value on high levels of cash holdings associated with CEO ownership, highlighting that CEO ownership aligns CEOs' interests with shareholders' benefits regarding corporate cash policy.

Our study also contributes to the existing literature on corporate governance by shedding light on the issue of managerial entrenchment. Previous studies have shown mixed evidence regarding the relationship between managerial ownership and corporate governance. For example, Morck et al. (1988) and Perrini et al. (2008) argue that when managerial ownership is low, external governance mechanisms can help mitigate agency conflicts. In contrast, Nikolov and Whited (2014) propose that low levels of managerial ownership can lead to misaligned incentives and increase managerial entrenchment. However, our findings consistently demonstrate that CEO ownership has a positive impact on cash holdings and increases the marginal value of cash. One possible explanation for this is that most CEOs in U.S. companies own only a small portion of their firms' common stocks, which nonetheless constitute a significant portion of their personal wealth. As a result, these "owner-CEOs" have strong incentives to maximize shareholder value (Elsilä et al., 2013; Lilienfeld-Toal & Ruenzi, 2014). Additionally, the effectiveness of corporate governance may be influenced by the economic and business environment. Prior studies suggest that idiosyncratic risk has been increasing over time, leading to higher levels of cash flow volatility which is difficult to be hedged (Campbell et al., 2001; Irvine & Pontiff, 2009). Thus, "owner-CEOs" are incentivized

to increase precautionary cash reserves against potential cash flow shortages and firm risks.

The remainder of the paper is organized as follows. Section 3 describes the data sources, variable definitions, and summary statistics. Section 4 presents empirical results and addresses potential endogeneity concerns. Section 5 investigates the channels through which CEO ownership affects cash holdings. Section 6 examines how CEO ownership affects the use of cash and the value of cash. Section 7 concludes.

2. Literature review

The economics and finance literature have identified several theoretical motives of cash holdings: precautionary motive (Bates et al., 2009; Ferreira & Vilela, 2004; Opler et al., 1999), agency conflict (Dittmar et al., 2003; Harford et al., 2008; Jensen, 1986; Pinkowitz et al., 2006), transaction costs (Baumol, 1952; Keynes, 1937; Miller & Orr, 1966; Mulligan, 1997), and taxes associated with foreign earnings (Foley et al., 2007). In this literature review, we focus on two key theoretical perspectives on corporate cash holdings which are directly related to our empirical analysis: the precautionary motive and the agency private benefit motive.

Empirical research on corporate cash policies has generally found support for the precautionary motive, which suggests that firms with valuable investment opportunities and volatile cash flow should accumulate precautionary cash reserves to protect themselves from adverse cash flow shocks. For example, Bates et al. (2009) study the rising trend in cash holdings by U.S. public firms and find that firms with riskier cash flows and higher R&D expenditures tend to hold more cash. Duchin (2010) and Derrien and Kecskés (2013) show that firms with higher cash holdings are less affected by exogenous increases in the cost of capital. Harford et al. (2014) investigate whether cash reserves enable firms to mitigate the underinvestment problem due to refinancing risk and find that firms mitigate refinancing risk by increasing their cash holdings and saving cash from cash flows. A recent study by Cunha and Pollet (2020) also document that firms hold more cash in response to the increases in demographic demand growth, and the relation is more pronounced for financially constrained firms. Based on the precautionary motive, cash is saved for the value creation purpose. Therefore, the value of additional cash is higher, especially for financially constrained firms and those with more investment opportunities (Denis & Sibilkov, 2010; Faulkender, 2005).

The role of agency conflicts in shaping firms' incentives to accumulate cash has also been highlighted in literature. Agency theory suggests that self-interested managers tend to accumulate large cash reserves to pursue their private benefits at the expense of shareholders' wealth, such as empire building and perquisite consumption (Jensen, 1986). In this vein, excess cash reserves aggregate agency problem by providing a pool of accumulated free cash flow, therefore, decreasing firm value (Dittmar & Mahrt-Smith, 2007; Dittmar et al., 2003; Harford, 1999; Pinkowitz et al., 2006). Further support for the agency motive of cash holdings is provided by Gao et al. (2013), who find that public firms hold more cash than private firms because public firms have lower precautionary motives but much higher agency conflicts than private firms. Moreover, Jiang and Lie (2016) study how managerial entrenchment affects firms' cash holding adjustment speed and find that self-interested managers are reluctant to distribute excess cash.

Prior work on corporate governance points out that managerial ownership plays a critical role in determining corporate cash holdings. Jensen and Meckling (1976) and Jensen (1986) posit that managerial ownership can align the interests of managers and shareholders, therefore mitigating managers' incentives to hold large cash reserves. Previous studies (Himmelberg et al., 1999; McConnell et al., 2008; Morck et al., 1988) also suggest that a higher level of managerial ownership may lead to a higher degree of managerial entrenchment,

and managers may choose to hold more cash to pursue their private benefits. Taken together, managerial ownership may lead to a non-monotonic influence on corporate cash holdings. Ozkan and Ozkan (2004) provide empirical evidence on this conjecture by using a sample of U.K. public firms from 1995 to 1999 and document a non-monotonic relationship between managerial ownership and cash holdings.

However, Chen (2008) and Chen and Chuang (2009) investigate whether the effect of CEO ownership on corporate cash policy differ between listed new economy firms and old economy firms. They find no non-monotonic relationship between CEO ownership and cash holdings but observe that corporate governance derived from CEO ownership is subjective to firms' product life cycle and investment opportunities. Compared to old economy firms, new economy firms face a more dynamic investment environment and higher level of business risks. To increase firm value, shareholders in listed new economy firms are willing to accept a high level of cash holdings when a low level of CEO ownership serves as an effective investor protection mechanism.

Recent studies also emphasize the impact of CEO attributes and demographics on corporate cash holdings. For instance, Tong (2010) finds that CEOs' risk-taking incentives have a positive association with cash holdings and a negative association with the value of cash. Meanwhile, Liu and Mauer (2011) show the opposite evidence on the implications of CEOs' risk-taking incentives on corporate cash holdings. Orens and Reheul (2013) investigate the impact of CEO demographics on cash holdings and document that older CEOs and CEOs without multi-industry experience are more concerned with the precautionary motive of cash and less concerned with the opportunity cost of cash. Moreover, Mun et al. (2020) highlight the effect of CEOs' education background on cash policy and value of excess cash in Korean firms.

Recently, a growing literature show that optimistic and overconfident CEOs hoard cash for future growth opportunities and spend relatively more cash for capital expenditure and acquisitions, leading to a positive effect of CEO overconfidence on the value of cash, especially for firms that are more likely to suffer from the underinvestment problem (Aktas et al., 2019; Chen et al., 2020; Huang-Meier et al., 2016). However, Deshmukh et al. (2021) find that optimistic CEOs hold lower cash to fund their firms' growth opportunities and save less cash out of incremental cash flows. They argue that optimistic CEOs view external financing as excessively costly but expect the costs to decrease in the future. Therefore, optimistic CEOs delay external financing while fund current investments with existing cash and maintain a lower cash balance than rational CEOs.

3. Data and variable construction

3.1. Sample selection and data sources

Our sample covers all firms in the S&P ExecuComp database from 1992 to 2018. We require that the firm-year observations in our sample have available data on managerial stock and option holdings, as well as accounting data available in Compustat. We obtain managerial entrenchment data from the Institutional Shareholder Service (ISS, formerly RiskMetrics) database and institutional ownership data from the Thomson Reuters s34 files. As cash holdings in financial firms (SIC codes 6000–6999) may be influenced by capital requirements and utility firms (SIC codes 4900–4999) are heavily regulated, we follow the literature on cash holdings and exclude firms from these two industries (e.g., Bates et al., 2009; Opler et al., 1999). Our main sample comprises of 26,409 firm-year observations that meet the criteria for our main empirical analyses.

3.2. Independent variables of interest: CEO ownership

We use two measures to proxy for CEO ownership. The first measure, *CEO_OWN*, captures a CEO's annual stock ownership. Following previous research on CEO ownership (Cui & Mak, 2002; Liliendorf-Toal & Ruenzi, 2014; Schiehl & Bellavance, 2009), *CEO_OWN* is defined as the percentage of the common share outstandings held by a CEO. This measure provides a proxy for a CEO's voting right on corporate policy. The percentage of voting rights owned by CEOs reflects their level of informational advantage (Fahlenbrach & Stulz, 2009; Leland & Pyle, 1977) and countervailing interest alignment (Jensen & Meckling, 1976; Kim & Lu, 2011). Therefore, we use *CEO_OWN* to examine CEOs' decisions on corporate cash policy and how these decisions impact shareholder value.

We use *CEO_OWN_SO* as our second measure of CEO ownership. This measure is defined as the delta of a CEO's stock and options divided by the delta of a firm's stock and options (Kim & Lu, 2011). In contrast to *CEO_OWN*, *CEO_OWN_SO* captures CEOs' incentives from both stocks and options. Since stock options have no voting rights, *CEO_OWN_SO* is the fraction of the total delta of all outstanding stock and options held by a CEO. To calculate this measure, we follow the methodology of Core and Guay (2002) and Edmans et al. (2009) and calculate the delta of a CEO's stock options and the delta of all outstanding stock options of the firm. For detailed calculations of *CEO_OWN_SO*, please refer to Appendix A.

3.3. Dependent variable and control variables

Following Bates et al. (2009), we measure corporate cash holdings as the ratio of cash and marketable securities to total assets.⁴ We also employ three alternative measures of cash ratio in our robustness tests: cash to net assets (Opler et al., 1999), industry-adjusted cash holdings (Haushalter et al., 2007), and excess cash holdings (Dittmar & Mahrt-Smith, 2007).

Following previous studies (e.g., Acharya et al., 2007; Bates et al., 2009; Opler et al., 1999), we control the following variables: *Size* is the natural logarithm of total assets, capturing the economies of scale of holding cash; *CF* is cash flows normalized by total assets, capturing the source of cash holdings; *MTB* is the market-to-book ratio, which is a proxy for future investment opportunities; *NWC* is net working capital, which is a proxy for the substitutes of liquid assets; *CAPEX* and *Acquisitions* are expenses associated with capital expenditures and acquisitions; *R&D/Sales* is research and development expenses normalized by total sales; *Dividends* is an indicator variable, equal to one if a firm pays common dividends and zero otherwise; *Sigma* is the average of the cash flow volatilities of firms within the same 2-digit SIC industry; *Leverage* is the ratio of total debt to total assets; and *Firm Age* is the natural logarithm of the number of years since the firm was reported in Compustat. The detailed definitions of these variables are provided in Appendix B (Table B.1).

3.4. Summary statistics

Table 1 presents the summary statistics of the variables used in our main empirical analyses. Our sample contains 26,409 firm-year observations from 1992 to 2018. All variables in dollar values are inflation-adjusted to 2018 dollars using the Consumer Price Index from the Federal Reserve Bank of St. Louis. We winsorize the accounting variables and ownership variables at the 1% and 99% levels. We first replicate Kim and Lu's (2011) sample period of 1992–2006 and find that the means (standard deviations) of *CEO_OWN* and *CEO_OWN_SO* are 2.7% (6.5%) and 3.0% (6.5%), which are comparable to 2.8%

⁴ Our results are robust to the ratio of cash to net assets and the natural logarithm of cash to total assets. These results are available upon request.

(6.6%) and 3.2% (6.5%) reported in their study. We then extend our sample period to 2018. Consistent with prior studies (Core et al., 1999; Fahlenbrach & Stulz, 2009; Kim & Lu, 2011), we find that the distribution of CEO stock ownership is right-skewed. The mean and median of *CEO_OWN* are 2.4% and 0.4%, and the mean and median of *CEO_OWN_SO* are 2.6% and 0.6%. On average, the cash holdings of our sample firms account for 14.7% of total assets. Figs. 1 and 2 show that for both CEO ownership measures, cash holdings monotonically increase with CEO ownership from 0% to 40%. Moreover, our sample firms on average generate positive operating cash flows of 8.3% and have leverage of 21.7%. The average net financing is 8.3% and the average R&D is 4.8%. The distributions of our variables are broadly consistent with those reported in earlier studies.

4. Main empirical results

4.1. Baseline regression models

To examine the empirical relationship between CEO ownership and corporate cash holdings, we adopt the following baseline regression:

$$\text{Cash holdings}_{i,t} = \alpha + \beta_1 \text{CEO ownership}_{i,t} + B \text{Control variables}_{i,t} + \mu_t + \theta_j + \epsilon_{i,t} \quad (1)$$

where i is firm index, t is year index and j is industry index. To control for the variations of corporate cash holdings across different industries and over time, we include year (μ_t) and Fama and French (1997) 48 industry (θ_j) fixed effects.

Table 2 presents the results of the baseline regressions. In columns (1) and (2), the coefficients of CEO ownership proxy variables are positive and statistically significant at the 1% level, indicating a positive association between CEO ownership and corporate cash holdings. Column (1) shows that a one-standard-deviation increase in *CEO_OWN_t* is associated with a 0.55% (= 0.098 × 0.056) increase in *Cash holdings_t*, which is equivalent to 3.7% of an average firm's cash holdings (=0.55%/0.147). Column (2) suggests that a one-standard-deviation increase in *CEO_OWN_SO_t* is associated with a 0.62% (= 0.111 × 0.056) increase in *Cash holdings_t*, which is equivalent to 4.2% of an average firm's cash holdings (=0.62%/0.147).⁵

The coefficients of our control variables are consistent with those documented in Bates et al. (2009), who study the relationship between corporate cash holdings and firm characteristics. Table 2 shows that cash holdings are positively associated with the market-to-book ratio, research and development expenses, and industry cash flow risk. Conversely, cash holdings are negatively associated with firm size, net working capital, capital expenditures, acquisition expenditures, leverage, dividend payments, and firm age. These results align with earlier research that indicates the precautionary demand for holding cash increases for firms with smaller size, younger firm age, better investment opportunities, higher external financing costs, and higher firm-specific risk (Acharya et al., 2007; Bates et al., 2009; Opler et al., 1999).

To explore the potential non-linear relationship between cash holdings and CEO ownership in our sample, we define three piecewise-linear terms of CEO ownership using cutoff points of 5% and 25%, as employed in prior studies (Kim & Lu, 2011; Morck et al., 1988; Opler et al., 1999). Specifically, *CEO_OWN_05* equals *CEO_OWN* if $0 < \text{CEO_OWN} < 5\%$, and 5% otherwise. Similarly, *CEO_OWN_0525* equals 0 if $\text{CEO_OWN} \leq 5\%$, *CEO_OWN* minus 5% if $5\% < \text{CEO_OWN} < 25\%$, and 20% otherwise. *CEO_OWN_25* equals 0 if $\text{CEO_OWN} \leq 25\%$, and *CEO_OWN* minus 25% otherwise. We also define corresponding

⁵ We also run regressions with one-year-lagged independent variables, and the results are statistically similar.

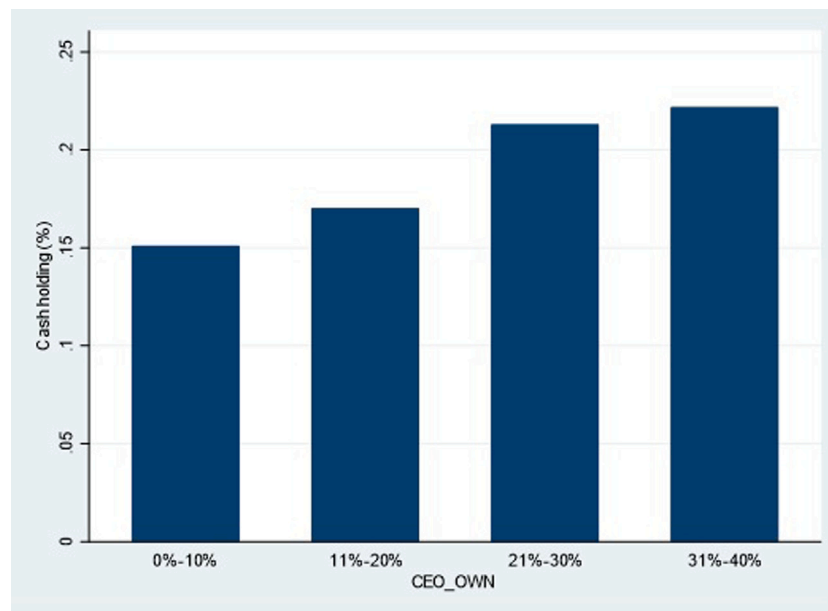


Fig. 1. Cash holdings and CEO ownership, measured by *CEO_OWN*.

This figure displays the average cash holdings grouped by *CEO_OWN* categories. Our analysis is based on a sample of 26,409 firm-year observations spanning the fiscal years 1992 to 2018. As the maximum value of *CEO_OWN* in our sample is 32.5%, we categorize the *CEO_OWN* into four percentage groups: 0%–10%, 11%–20%, 21%–30%, and 31%–40%. The figure shows that there is a steady rise in cash holdings as *CEO_OWN* increases from 0% to 40%.

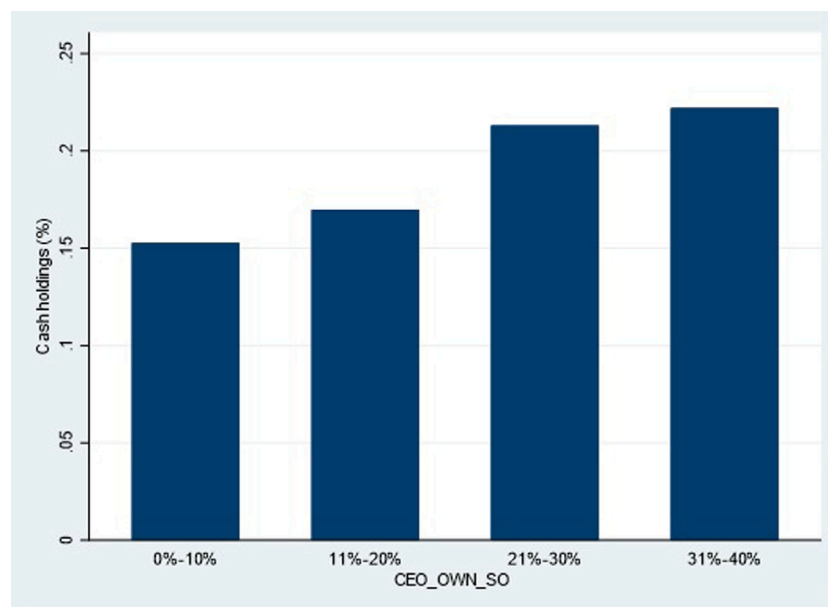


Fig. 2. Cash holdings and CEO ownership, measured by *CEO_OWN_SO*.

This figure displays the average cash holdings grouped by *CEO_OWN_SO* categories. Our analysis is based on a sample of 26,409 firm-year observations spanning the fiscal years 1992 to 2018. As the maximum value of *CEO_OWN_SO* in our sample is 32.9%, we categorize the *CEO_OWN_SO* into four percentage groups: 0%–10%, 11%–20%, 21%–30%, and 31%–40%. The figure shows that there is a monotonically increase in cash holdings as *CEO_OWN_SO* increases from 0% to 40%.

piecewise-linear terms for *CEO_OWN_SO*, denoted as *CEO_OWN_SO_05*, *CEO_OWN_SO_0525*, and *CEO_OWN_SO_25*. These piecewise-linear terms enable the slope coefficient to vary at the 5% and 25% cutoff points. We then substitute *CEO_OWN* or *CEO_OWN_SO* with the corresponding piecewise-linear terms in the baseline regressions. Results in columns (3)–(4) of Table 2 show that the coefficients of the piecewise-linear terms are all positive and statistically significant, suggesting that the positive and linear relationship between cash holdings and CEO ownership holds between 5% and 25% cutoff points. Nevertheless, the coefficients decrease as CEO ownership increases, indicating that the

marginal effect of CEO ownership on cash holdings diminishes with increasing CEO ownership.⁶

⁶ We conduct a U test (Lind & Mehlum, 2010) to examine whether there is a U-shaped or inverse U-shaped relation between cash holdings and CEO ownership. The results indicate that we cannot reject the null hypothesis that there is only a monotonic relation exists. We also add the square of our CEO ownership measures in our baseline regressions and find that the estimated coefficients of the square terms are not statistically significant, suggesting that there is not a non-linear relation between cash holding and CEO ownership.

Table 1
Summary statistics.

| Variable | Obs. | Mean | S.D. | p1 | p25 | Median | p75 | p99 |
|--|--------|--------|-------|--------|--------|--------|-------|--------|
| Dependent variables | | | | | | | | |
| <i>Cash holdings_i</i> | 26,409 | 0.147 | 0.166 | 0.001 | 0.026 | 0.082 | 0.209 | 0.743 |
| Independent variables of interest | | | | | | | | |
| <i>CEO_OWN_i</i> | 26,409 | 0.024 | 0.056 | 0.000 | 0.001 | 0.004 | 0.015 | 0.325 |
| <i>CEO_OWN_SO_i</i> | 26,409 | 0.026 | 0.056 | 0.000 | 0.002 | 0.006 | 0.018 | 0.329 |
| Control variables | | | | | | | | |
| <i>Size_i</i> | 26,409 | 7.518 | 1.509 | 4.333 | 6.447 | 7.376 | 8.481 | 11.451 |
| <i>CF_i</i> | 26,409 | 0.083 | 0.078 | -0.269 | 0.055 | 0.086 | 0.121 | 0.265 |
| <i>MTB_i</i> | 26,409 | 1.993 | 1.244 | 0.731 | 1.232 | 1.612 | 2.274 | 7.491 |
| <i>NWC_i</i> | 26,409 | 0.083 | 0.144 | -0.272 | -0.011 | 0.071 | 0.170 | 0.463 |
| <i>CAPEX_i</i> | 26,409 | 0.057 | 0.053 | 0.004 | 0.022 | 0.040 | 0.072 | 0.298 |
| <i>R&D/Sales_i</i> | 26,409 | 0.048 | 0.112 | 0.000 | 0.000 | 0.002 | 0.047 | 0.724 |
| <i>Acquisitions_i</i> | 26,409 | 0.031 | 0.065 | -0.002 | 0.000 | 0.001 | 0.028 | 0.345 |
| <i>Dividends_i</i> | 26,409 | 0.509 | 0.500 | 0 | 0 | 1 | 1 | 1 |
| <i>Sigma_i</i> | 26,409 | 0.053 | 0.022 | 0.018 | 0.034 | 0.052 | 0.069 | 0.111 |
| <i>Leverage_i</i> | 26,409 | 0.217 | 0.169 | 0.000 | 0.067 | 0.208 | 0.328 | 0.665 |
| <i>Firm age_i</i> | 26,409 | 3.132 | 0.649 | 1.792 | 2.639 | 3.178 | 3.689 | 4.205 |
| <i>Vega/TC_i</i> | 25,725 | 0.025 | 0.031 | 0.000 | 0.006 | 0.016 | 0.032 | 0.195 |
| <i>CEO age_i</i> | 25,769 | 55.807 | 7.491 | 39 | 51 | 56 | 60 | 76 |
| <i>CEO female_i</i> | 26,409 | 0.026 | 0.159 | 0 | 0 | 0 | 0 | 1 |
| <i>CEO duality_i</i> | 26,409 | 0.466 | 0.499 | 0 | 0 | 0 | 1 | 1 |
| <i>CEO education_i</i> | 16,911 | 2.659 | 0.737 | 1 | 2 | 3 | 3 | 4 |
| <i>CEO overconfidence_i</i> | 20,353 | 0.675 | 0.468 | 0 | 0 | 1 | 1 | 1 |
| <i>CEO tenure_i</i> | 24,833 | 8.458 | 7.408 | 1 | 3 | 6 | 11 | 35 |
| <i>CEO tax burden_i</i> | 22,614 | 0.040 | 0.163 | -0.833 | 0.000 | 0.051 | 0.129 | 0.269 |
| Governance variables | | | | | | | | |
| <i>E-Index_i</i> | 15,850 | 3.324 | 1.370 | 0 | 2 | 3 | 4 | 6 |
| <i>TMI_i</i> | 26,203 | 0.187 | 0.181 | 0.000 | 0.036 | 0.133 | 0.291 | 0.674 |

This table presents the summary statistics of our main variables. Our sample consists of 26,409 firm-year observations over the fiscal years 1992–2018, with required data for our main empirical analyses. We report the number of observations, mean, standard deviation, 1st percentile, 25th percentile, median, 75th percentile, and 99th percentile. Variable definitions are in Appendix B (Table B.1). All accounting variables in dollars are inflation-adjusted to 2018 dollars. All inflation-adjusted accounting variables and stock return variables are winsorized at the 1% and 99% levels.

According to Harford et al. (2008), the equity ownership of the top five executives is positively related to cash holdings. In our study, we use *Top5_OWN* and *Top5_OWN_SO* as proxies for the ownership of the five executives with the highest compensation in the firm. As shown in columns (5)–(6) of Table 2, the coefficients of *Top5_OWN* and *Top5_OWN_SO* are positive and statistically significant, indicating a positive relationship between insider ownership and cash holdings. To investigate the importance of CEO ownership compared to other top executives, we subtract CEO ownership from *Top5_OWN* and *Top5_OWN_SO* and define *Top4_OWN* and *Top4_OWN_SO* as the non-CEO insider ownership. However, as shown in columns (7) and (8), the coefficients of *Top4_OWN* and *Top4_OWN_SO* are statistically insignificant. These results suggest that CEO ownership plays a more critical role in determining corporate cash policy than the ownership of other top executives.

4.2. Identification methods

The baseline regression results indicate a positive effect of CEO ownership on corporate cash holdings. However, it is important to note that CEOs and firms do not randomly select each other in the labor market, raising potential endogeneity concerns. For instance, a CEO may choose to join a firm with better investment prospects and higher financing flexibility. Additionally, unobservable characteristics such as corporate reputation and managerial traits could impact both CEO ownership and corporate cash policy. To address these potential endogeneity concerns, we use two identification strategies: a Propensity Score Matching (PSM) method, a Two-Stage least squares (2SLS) model, and alternative models with the Generalized Method of Moments (GMM) estimation and the high-dimensional fixed effects (HDFFE).

4.2.1. Propensity score matching

A firm may appoint a CEO with specific managerial styles according to the firm's specific strategies, including cash policy. CEO ownership and cash holdings may also be jointly determined by firm characteristics, such as firm size. Smaller firms may have more cash holdings and higher CEO ownership. To address the concern about non-random matching between CEOs and firms, we employ a PSM approach to compare the cash holdings of two groups of firms that are similar in terms of observable firm characteristics except CEO ownership. Firms with high CEO ownership are assigned into a treatment group and those with low CEO ownership are assigned into a control group.

Following the setting in Lilienfeld-Toal and Ruenzi (2014) and Liu and Maurer (2011), we classify firms into two sub-samples based on the annual median of CEO ownership. Specifically, we define dummy variables *OWN_High* and *OWN_SO_High* which are equal to one if *CEO_OWN* and *CEO_OWN_SO* are above their annual sample median, and zero otherwise. In the first stage of our PSM procedure, we employ a probit model to estimate the probabilities (propensity scores) that firms have a CEO with high ownership. In the probit regressions, the dependent variables are *OWN_High* and *OWN_SO_High*, and the independent variables are the control variables in Eq. (1). Columns (1) and (3) of Panel A of Table 3 report the results of pre-matching probit regressions. We observe that CEOs ownership are associated with smaller firm size, younger age, lower cash flows, less R&D, higher net working capital, more capital expenditures, more acquisition expenses, and higher leverage.

In the second stage of PSM procedure, we conduct a one-to-one nearest neighbor matching using the estimated propensity scores from the first stage. We require that the differences in the propensity scores

Table 2
Baseline regression: CEO ownership and corporate cash holdings.

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|------------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| <i>CEO_OWN_i</i> | 0.098*** [2.88] | | | | | | | |
| <i>CEO_OWN_SO_i</i> | | 0.111*** [3.09] | | | | | | |
| <i>CEO_OWN_05_i</i> | | | 0.299* [1.76] | | | | | |
| <i>CEO_OWN_0525_i</i> | | | 0.103** [2.41] | | | | | |
| <i>CEO_OWN_25_i</i> | | | 0.099** [2.23] | | | | | |
| <i>CEO_OWN_SO_05_i</i> | | | | 0.284* [1.78] | | | | |
| <i>CEO_OWN_SO_0525_i</i> | | | | 0.103** [2.40] | | | | |
| <i>CEO_OWN_SO_25_i</i> | | | | 0.126*** [2.86] | | | | |
| <i>Top5_OWN_i</i> | | | | | 0.066** [2.47] | | | |
| <i>Top5_OWN_SO_i</i> | | | | | | 0.071*** [2.61] | | |
| <i>Top4_OWN_i</i> | | | | | | | 0.061 [1.32] | |
| <i>Top4_OWN_SO_i</i> | | | | | | | | 0.068 [1.40] |
| <i>Size_i</i> | -0.019*** [-12.13] | -0.019*** [-12.09] | -0.019*** [-11.80] | -0.019*** [-11.81] | -0.019*** [-12.15] | -0.019*** [-12.15] | -0.019*** [-12.33] | -0.019*** [-12.34] |
| <i>CF_i</i> | -0.037 [-1.56] | -0.036 [-1.55] | -0.037 [-1.56] | -0.037 [-1.57] | -0.050** [-2.01] | -0.050** [-2.00] | -0.052** [-2.08] | -0.052** [-2.08] |
| <i>MTB_i</i> | 0.023*** [14.68] | 0.023*** [14.67] | 0.687*** [7.74] | 0.685*** [7.72] | 0.024*** [15.12] | 0.024*** [15.09] | 0.024*** [15.16] | 0.024*** [15.15] |
| <i>NWC_i</i> | -0.288*** [-19.74] | -0.288*** [-19.73] | 0.023*** [14.70] | 0.023*** [14.69] | -0.276*** [-18.93] | -0.276*** [-18.89] | -0.274*** [-18.82] | -0.274*** [-18.81] |
| <i>CAPEX_i</i> | -0.544*** [-17.58] | -0.544*** [-17.58] | -0.289*** [-19.75] | -0.289*** [-19.73] | -0.534*** [-17.21] | -0.535*** [-17.19] | -0.532*** [-17.19] | -0.532*** [-17.19] |
| <i>R&D/Sales_i</i> | 0.437*** [16.23] | 0.437*** [16.25] | -0.545*** [-17.60] | -0.545*** [-17.59] | 0.466*** [15.91] | 0.467*** [15.92] | 0.463*** [15.83] | 0.463*** [15.83] |
| <i>Acquisitions_i</i> | -0.315*** [-23.94] | -0.315*** [-23.98] | -0.206*** [-18.83] | -0.206*** [-18.86] | -0.302*** [-23.21] | -0.302*** [-23.25] | -0.302*** [-23.28] | -0.303*** [-23.29] |
| <i>Dividends_i</i> | -0.017*** [-4.59] | -0.017*** [-4.58] | -0.017*** [-4.58] | -0.017*** [-4.57] | -0.017*** [-4.55] | -0.017*** [-4.54] | -0.017*** [-4.45] | -0.017*** [-4.45] |
| <i>Sigma_i</i> | 0.687*** [7.74] | 0.686*** [7.72] | 0.437*** [16.22] | 0.437*** [16.23] | 0.653*** [7.34] | 0.650*** [7.31] | 0.658*** [7.39] | 0.657*** [7.38] |
| <i>Leverage_i</i> | -0.205*** [-18.79] | -0.205*** [-18.81] | -0.315*** [-23.92] | -0.316*** [-23.94] | -0.195*** [-17.34] | -0.195*** [-17.38] | -0.197*** [-17.27] | -0.197*** [-17.28] |
| <i>Firm age_i</i> | -0.008*** [-2.89] | -0.008*** [-2.89] | -0.008*** [-2.85] | -0.008*** [-2.86] | -0.006** [-2.29] | -0.006** [-2.31] | -0.007** [-2.50] | -0.007** [-2.49] |
| Constant | 0.342*** [14.26] | 0.341*** [14.28] | 0.338*** [13.96] | 0.337*** [14.10] | 0.328*** [12.99] | 0.328*** [13.02] | 0.335*** [12.75] | 0.335*** [12.76] |
| Industry fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 26,409 | 26,409 | 26,409 | 26,409 | 24,911 | 24,911 | 24,911 | 24,911 |
| Adjusted-R ² | 0.586 | 0.586 | 0.587 | 0.587 | 0.583 | 0.583 | 0.582 | 0.582 |

This table presents the OLS regressions of corporate cash holdings on CEO ownership proxy variables and control variables. The sample consists of 26,409 firm-year observations of U.S. firms over the sample period of 1992–2018 with required data for the regressions. The dependent variable is *Cash holdings*, and the independent variables of interest are CEO ownership (*CEO_OWN_i*, and *CEO_OWN_SO_i*), the piecewise-linear terms of CEO ownership (*CEO_OWN_05_i*, *CEO_OWN_0525_i*, *CEO_OWN_25_i*, *CEO_OWN_SO_05_i*, *CEO_OWN_SO_0525_i*, and *CEO_OWN_SO_25_i*), insider ownership (*Top5_OWN_i* and *Top5_OWN_SO_i*), and non-CEO insider ownership (*Top4_OWN_i* and *Top4_OWN_SO_i*). All variables are defined in Appendix B (Table B.1). The coefficients of the year and Fama–French 48 industry fixed effects are suppressed for brevity in the respective columns. *t*-statistics based on standard errors clustered at the firm level are reported in brackets. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

between treatment firms and matched control firms do not exceed 0.5% in absolute value. Based on this criterion, we obtain 8297 paired firms with 16,594 firm-year observations using *CEO_OWN*, and 8218 paired firms with 16,436 firm-year observations using *CEO_OWN_SO*.

To ensure the treatment and control groups are comparable, we further conduct two diagnostic tests. The first is the post-match diagnostic regression based on the PSM matched sample. The results are reported in columns (2) and (4) of Panel A of Table 3. All the estimated coefficients are statistically insignificant, and the F-statistics of the Hotelling test show that we do not reject the null hypothesis that the vector of means are equal between the treatment and control

groups. These results indicate that the characteristics of treatment and control firms are not significantly different. In addition, the coefficients in columns (2) and (4) have much smaller absolute value than the corresponding coefficients in columns (1) and (3), suggesting that the decrease in the statistical significance is not only due to the drop in the sample size.

The second diagnostic test is the univariate comparisons of firm characteristics between treatment and control groups. Panel B of Table 3 reports the result. Columns (1)–(2) and (4)–(5) display the means of firm characteristics. The *t*-statistics in columns (3) and (6) show that all the differences in the mean values of firm characteristics between

Table 3
Propensity score matching.

| Variables | OWN_High | | OWN_SO_High | |
|----------------------------------|-----------------------|--------------------|-----------------------|--------------------|
| | Pre-match (1) | Post-match (2) | Pre-match (3) | Post-match (4) |
| <i>Size_t</i> | -0.114*** [-20.11] | 0.003 [0.33] | -0.111*** [-20.94] | 0.003 [0.37] |
| <i>CF_t</i> | -0.170** [-2.19] | -0.112 [-1.22] | -0.072 [-0.98] | -0.076 [-0.86] |
| <i>MTB_t</i> | 0.001 [0.23] | 0.002 [0.25] | 0.013** [2.49] | 0.003 [0.45] |
| <i>NWC_t</i> | 0.278*** [5.05] | -0.010 [-0.15] | 0.312*** [5.86] | -0.006 [-0.09] |
| <i>CAPEX_t</i> | 0.326** [2.44] | 0.068 [0.42] | 0.349*** [2.67] | 0.195 [1.20] |
| <i>R&D/Sales_t</i> | -0.352*** [-4.55] | -0.042 [-0.46] | -0.371*** [-4.90] | -0.037 [-0.40] |
| <i>Acquisitions_t</i> | 0.127** [2.38] | -0.026 [-0.37] | 0.232*** [4.34] | -0.016 [-0.22] |
| <i>Dividends_t</i> | 0.004 [0.27] | 0.001 [0.06] | -0.014 [-0.95] | -0.002 [-0.10] |
| <i>Sigma_t</i> | -0.372 [-0.88] | 0.001 [0.00] | -0.642 [-1.62] | 0.011 [0.02] |
| <i>Leverage_t</i> | 0.110*** [2.71] | -0.038 [-0.78] | 0.081** [2.06] | -0.005 [-0.10] |
| <i>Firm age_t</i> | -0.060*** [-4.86] | 0.013 [0.88] | -0.073*** [-6.18] | 0.012 [0.85] |
| Constant | 1.444*** [13.40] | 0.509*** [3.71] | 1.465*** [14.00] | 0.527*** [3.78] |
| Hotelling F-stat | | 0.748 | | 0.902 |
| Industry fixed effects | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes |
| Observations | 26,409 | 16,594 | 26,409 | 16,436 |
| Adjusted-R ² | 0.166 | 0.001 | 0.177 | 0.003 |

Panel A. Pre-match propensity score regressions and post-match diagnostic regressions. This panel reports the parameters estimated from the probit model, which are used to calculate the propensity scores. The dependent variable is *OWN_High_t* in columns (1) and (2), and *OWN_SO_High_t* in columns (3) and (4). *OWN_High_t* (*OWN_SO_High_t*) is equal to one if *CEO_OWN_t* (*CEO_OWN_SO_t*) is above its annual sample median, and zero otherwise. The independent variables are all the firm characteristics included in Eq. (1). Columns (1) and (3) report the pre-match propensity score regressions. Columns (2) and (4) report the post-match diagnostic regressions. Hotelling test (F-statistics) examines whether the vector of means are equal for the treatment and control groups, with a null hypothesis that the means are equal between the two groups. All variables are defined in Appendix B (Table B.1). The coefficients of the year and Fama–French 48 industry fixed effects are suppressed for brevity in the respective columns. *t*-statistics based on standard errors clustered at the firm level are reported in brackets. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

| Variables | OWN matched sample (16,594 Obs.) | | | OWN_SO matched sample (16,436 Obs.) | | |
|----------------------------------|-------------------------------------|------------|----------------|--|------------|----------------|
| | High (1) | Low (2) | t-stat. (3) | High (4) | Low (5) | t-stat. (6) |
| <i>Size_t</i> | 7.379 | 7.364 | 0.78 | 7.372 | 7.360 | 0.60 |
| <i>CF_t</i> | 0.081 | 0.083 | -1.14 | 0.080 | 0.082 | -1.37 |
| <i>MTB_t</i> | 1.981 | 1.977 | 0.22 | 1.969 | 1.973 | -0.21 |
| <i>NWC_t</i> | 0.086 | 0.087 | -0.47 | 0.086 | 0.086 | 0.04 |
| <i>CAPEX_t</i> | 0.056 | 0.056 | 0.54 | 0.056 | 0.056 | 0.04 |
| <i>R&D/Sales_t</i> | 0.051 | 0.052 | -0.74 | 0.051 | 0.051 | 0.06 |
| <i>Acquisitions_t</i> | 0.032 | 0.032 | -0.23 | 0.031 | 0.032 | -0.57 |
| <i>Dividends_t</i> | 0.483 | 0.475 | 1.06 | 0.486 | 0.484 | 0.30 |
| <i>Sigma_t</i> | 0.053 | 0.052 | 0.79 | 0.053 | 0.053 | 0.02 |
| <i>Leverage_t</i> | 0.218 | 0.218 | -0.10 | 0.219 | 0.219 | -0.11 |
| <i>Firm age_t</i> | 3.103 | 3.086 | 1.67* | 3.106 | 3.092 | 1.41 |

Panel B. Differences in firm characteristics between CEOs with high and low ownership. This panel reports the univariate comparisons of firm characteristics between firms with high CEO ownership and propensity-score-matched firms with low CEO ownership. We employ a probit model to estimate the propensity scores, in which the dependent variables are *OWN_High_t* and *OWN_SO_High_t*, and the independent variables are the control variables in Eq. (1). *OWN_High_t* is equal to one if *CEO_OWN_t* is above its annual sample median, and zero otherwise. *OWN_SO_High_t* is equal to one if *CEO_OWN_SO_t* is above its annual sample median, and zero otherwise. We conduct a one-to-one nearest neighbor match. The differences in the propensity scores between firms with high CEO ownership and matched firms with low CEO ownership do not exceed 0.5% in absolute value. In columns (1)–(2) and (4)–(5), we report the mean of firm characteristics. In columns (3) and (6), we report the *t*-statistics of the univariate comparisons between the high and low sub-samples. All variables are defined in Appendix B (Table B.1). ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

(continued on next page)

Table 3 (continued).

| Variables | (1) | (2) |
|------------------------|-----------------------|-----------------------|
| CEO_OWN_t | 0.105*** [2.66] | |
| $CEO_OWN_SO_t$ | | 0.140*** [3.19] |
| $Size_t$ | -0.019*** [-9.89] | -0.019*** [-9.73] |
| CF_t | -0.010 [-0.40] | -0.012 [-0.47] |
| MTB_t | 0.023*** [12.93] | 0.023*** [12.65] |
| NWC_t | -0.283*** [-16.93] | -0.275*** [-16.42] |
| $CAPEX_t$ | -0.580*** [-15.82] | -0.550*** [-16.21] |
| $R\&D/Sales_t$ | 0.449*** [15.56] | 0.434*** [14.97] |
| $Acquisitions_t$ | -0.320*** [-20.84] | -0.315*** [-20.04] |
| $Dividends_t$ | -0.021*** [-5.08] | -0.021*** [-5.08] |
| $Sigma_t$ | 0.635*** [6.34] | 0.721*** [7.27] |
| $Leverage_t$ | -0.202*** [-16.22] | -0.203*** [-16.06] |
| $Firm\ age_t$ | -0.007** [-2.09] | -0.006* [-1.84] |
| Constant | 0.334*** [13.18] | 0.338*** [14.12] |
| Industry fixed effects | Yes | Yes |
| Year fixed effects | Yes | Yes |
| Observations | 16,594 | 16,436 |
| Adjusted- R^2 | 0.605 | 0.595 |

Panel C. CEO ownership and corporate cash holdings using the PSM samples. This panel reports the results of re-estimating Equation (1) using the propensity-score-matched samples. The dependent variable is *Cash holdings*, and the independent variables of interest are CEO_OWN_t and $CEO_OWN_SO_t$. The control variables are the same as those in Eq. (1). All variables are defined in Appendix B (Table B.1). The coefficients of the year and Fama-French 48 industry fixed effects are suppressed for brevity in the respective columns. *t*-statistics based on standard errors clustered at the firm level are reported in brackets. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

treatment and control groups are not statistically significant, except for *Firm age*, in column (3). These results indicate that firms in the treatment and control groups are comparable in terms of observable firm characteristics.

Finally, we re-estimate Eq. (1) using the PSM matched samples. The coefficients of CEO_OWN_t and $CEO_OWN_SO_t$ reported in Panel C of Table 3, remain positive and statistically significant at the 1% level. On average, a one-standard-deviation increase in CEO_OWN_t is associated with a 0.55% ($= 0.105 \times 0.052$) increase in *Cash holdings*, and a one-standard-deviation increase in $CEO_OWN_SO_t$ is associated with a 0.69% ($= 0.140 \times 0.049$) increase in *Cash holdings*.⁷ These results are consistent with those documented in our baseline regressions.

4.2.2. Two-stage least squares

Our PSM identification method helps to mitigate the endogeneity concern due to observable firm heterogeneity. However, it cannot address the endogeneity due to unobservable heterogeneity across CEOs and firms, such as CEOs' early-life experiences and firm culture. For instance, Bernile et al. (2017) find that CEOs with some fatal disaster experiences are associated with riskier corporate policies, such as higher leverage and lower cash holdings. To further address the potential endogeneity concerns due to time-variant omitted variables and reverse causality, our second identification strategy is to employ a 2SLS model with IVs.

⁷ The mean values of CEO_OWN and CEO_OWN_SO are 0.052 and 0.049 in the PSM matched sample.

Following Kim and Lu (2011), we adopt *CEO tenure* and *CEO tax burden* as our IVs for CEO ownership. Gibbons and Murphy (1992) and Palia (2001) show that executives' equity ownership increases with their tenure in the firms. CEO tenure is commonly employed as the IV for managerial equity ownership in previous studies (e.g., Brockman et al., 2010; Liu & Mauer, 2011). We define *CEO tenure* as the number of years a CEO has served in her position. Previous studies also document a positive relationship between CEOs' capital gain tax liabilities (tax burdens) and the amount of unrestricted equity ownership, suggesting that greater personal tax burdens significantly discourage CEOs from selling their stocks (Armstrong et al., 2015; Jin & Kothari, 2008). In this vein, CEOs with a high capital gain tax rate may choose to hold more unconstrained shares than CEOs with a low capital gain tax rate. Following Jin and Kothari (2008) and Yost (2018), we use the sum of the maximum marginal federal and state individual capital gains tax rates to construct the CEO tax burden.⁸ Specifically, *CEO tax burden* is defined as the tax liability arising from selling a CEO's vested stock holdings, scaled by the CEO's total equity holdings (including vested and unvested stock and options):

$$CEO\ tax\ burden_t = \frac{\sum_{k=1}^t (P_t - P_k) \times N_k \times t_{cg}}{Total\ equity\ holdings_t} \quad (2)$$

where P_t is the stock price at the end of year t , P_k is the stock price at the end of year k , N_k is the number of unrestricted shares held by the CEO in year t which were obtained in year k , t_{cg} is the sum of a

⁸ The data on the federal and state individual maximum marginal capital gains tax rates are collected from the National Bureau of Economic Research.

CEO's maximum marginal federal and state capital gains tax rates in year t , and *Total equity holdings_t*, is the total value of the CEO's stock and options holdings in year t .

Table 4 presents the results of our 2SLS regressions. Columns (1) and (2) report the results of the first-stage regressions in which the dependent variables are *CEO_OWN* and *CEO_OWN_SO*, respectively. *CEO tenure* and *CEO tax burden* are used as IVs, and the control variables are the same as those in Eq. (1). The coefficients of *CEO tax burden* are positive and statistically significant at the 5% and 1% levels, suggesting that CEO ownership is positively associated with tax burden. The coefficients of *CEO tenure* are positive and statistically significant at the 1% level, indicating that CEO ownership increases with CEO tenure. The sign of our IVs is consistent with the evidence documented in previous studies. The Shea's partial R^2 values are above the hurdle of 10% and the Kleibergen–Paap (KP) F-statistics are higher than 10, which supports the relevance condition that our IVs explain the variation of the potential endogenous CEO ownership variables.

Columns (3) and (4) report the results of the second-stage regressions, in which the dependent variable is *Cash holdings* and the independent variables of interest are predicted CEO ownership proxy variables obtained from the first-stage regressions. The control variables in the second-stage regressions are the same as those in Eq. (1). The coefficients of $\widehat{CEO_OWN}$ and $\widehat{CEO_OWN_SO}$ are positive and statistically significant at the 1% level, suggesting that the positive impact of CEO ownership on cash holdings remains robust to the 2SLS identification method. Our untabulated results also remain robust if we conduct 2SLS regressions with only one instrumental variable, either *CEO tenure* or *CEO tax burden*. These findings further mitigate the weak instrumentation concern and over-identification issues.

4.2.3. Dynamic panel and fixed effects models

To further address the endogeneity, we employ a GMM estimation method (e.g., Chen, 2008; Ozkan & Ozkan, 2004). The GMM method provides consistent parameter estimates by utilizing instruments that can be obtained from the orthogonality conditions existing between the lagged values of the variables and disturbances (Arellano & Bover, 1995). In addition, since unobservable variables that are correlated with both CEO ownership and corporate cash holdings may lead to estimation biases and preclude the causal inference in our study, we adopt various fixed effects models to address the endogeneity concern due to omitted variables. Apart from the model with firm and year fixed effects, we follow Gormley and Matsa's (2014) advice and adopt a high-dimensional fixed effects (HDFFE) model. Specifically, we control unobservable heterogeneity across firms and time-varying heterogeneity across industries in our baseline regressions.

Table 5 reports the GMM estimates of the dynamic cash model and the results of alternative fixed effects models. Columns (1) and (2) present the GMM estimates of the dynamic cash model, where the dependent and explanatory variables are assumed to be endogenous, and the lagged values of dependent and explanatory variables are used as instruments (Ozkan & Ozkan, 2004). The coefficients of GMM estimations show that the positive relation between CEO ownership and corporate cash holdings is statistically significant in dynamic panel models.⁹ Columns (3) and (4) report the results of the regressions controlling for the firm and year fixed effects. The coefficients of CEO ownership proxy variables are all positive and statistically significant at the 10% level. Columns (5) and (6) show similar results of the HDFFE

⁹ We also employ the impulse response functions (IRFs) of the dynamic model to check if the positive relation maintains over time. The unreported IRFs graphs show that a positive shock to *CEO_OWN* (*CEO_OWN_SO*) increases corporate cash holdings, and the positive effect dies out after period ten (thirteen), where the lower bound confidence interval is zero. Therefore, we conclude that CEO ownership has a positive and persistent impact on corporate cash holdings.

regressions with the firm fixed effects and the Fama–French 48 industry \times year fixed effects. The positive relation between CEO ownership and corporate cash holdings remains robust after controlling for unobserved heterogeneity.

4.3. Alternative measures of cash holdings

So far, we focus on the total amount of corporate cash holdings, which is the sum of cash and marketable securities. In this section, we examine whether our main results are robust to two alternative measures of cash holdings. First, we examine the excess cash holdings that are non-essential for corporate operations and investment. We define excess cash holdings (*Xcash*) as the amount of cash holdings above a predicted optimal level of cash reserves. Specifically, *Xcash* is the residual estimated from a regression in which the dependent variable is the ratio of cash and marketable securities to total assets, and the independent variables are firm net assets, industry average cash flow volatility, free cash flow, net working capital, market value of equity, and R&D expenses.¹⁰ Following Dittmar and Mahrt-Smith (2007) and Bates et al. (2009), we focus on the firm–year observations with positive excess cash holdings. Second, we adopt industry-adjusted cash holdings as our second alternative measure of cash holdings. Since corporate cash policy may be subject to industry-specific shocks, we follow Haushalter et al. (2007) and define *Industry-adjusted cash holdings* as the cash to total assets ratio minus the median of the cash to total assets ratios of all sample firms with the same 4-digit SIC codes. Table 6 shows that the positive relationship holds when we consider excess cash holdings, which are non-essential for corporate operations and investment, and when we adjust for industry-specific shocks in cash policy.

4.4. Additional controls for corporate governance and CEO characteristics

The previous literature documents that managerial entrenchment is related to corporate cash policy. For instance, Harford et al. (2008) show that firms with weaker shareholder rights have lower cash reserves. Nikolov and Whited (2014) also find that agency problems affect corporate cash policy, while institutional investors may mitigate these agency problems. To control for the effect of corporate governance on cash holdings, we include two governance proxy variables as additional control variables. The first one is the *E-index*, which measures the accumulated number of the six important anti-takeover provisions developed by Bebchuk et al. (2009). Firms with more anti-takeover provisions have more entrenched managers and poorer corporate governance. The second one is the *TMI*, which measures the ownership of motivated monitoring institutional investors whose holding value in a firm ranks among the top 10% of the stocks in their portfolios (Fich et al., 2015; Ward et al., 2018). Firms with a larger motivated monitoring institutional ownership have better corporate governance. The results in columns (1) and (2) of Table 7 show that after controlling for corporate governance, firms with higher CEO ownership tend to hold more cash. Consistent with the evidence documented in Harford et al. (2008) and Nikolov and Whited (2014), we find that firms' cash holdings increase when they have lower managerial entrenchment and higher institutional monitoring ownership.

Apart from controlling for corporate governance, we also control for the heterogeneity of CEO-level characteristics: *CEO age*, *CEO gender*, the sensitivity of a CEO's stock options to stock price volatility (*Vega/TC*), a CEO's managerial power within the firm (*CEO duality*), CEO education background (*CEO education*), and CEO overconfidence (*CEO overconfidence*). Columns (3)–(6) of Table 7 report that the positive relationship between CEO ownership and corporate cash holdings remains significant even after controlling for CEO-level characteristics.

¹⁰ Please refer to the Appendix of Dittmar and Mahrt-Smith (2007) for the details of the regression specification.

Table 4
Two-stage least squares.

| Variables | 2SLS 1st-stage | | 2SLS 2nd-stage | |
|----------------------------|---------------------|-------------------------|---------------------------|---------------------|
| | CEO_OWN_t (1) | $CEO_OWN_SO_t$ (2) | $Cash\ holdings_t$ (3) | (4) |
| $\widehat{CEO_OWN}_t$ | | | 0.236*** [3.13] | |
| $\widehat{CEO_OWN_SO}_t$ | | | | 0.274*** [3.15] |
| $CEO\ tax\ burden_t$ | 0.010** [2.49] | 0.011*** [2.99] | | |
| $CEO\ tenure_t$ | 0.003*** [14.44] | 0.002*** [14.13] | | |
| Constant | 0.089*** [3.90] | 0.085*** [3.69] | 0.327*** [12.86] | 0.325*** [12.73] |
| Control variables | Yes | Yes | Yes | Yes |
| Industry fixed effects | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes |
| Shea partial R^2 | 0.171 | 0.155 | | |
| KP F-stat.(IVs)-weakid | 111.923*** | 106.523*** | | |
| KP LM-underid | 114.568*** | 111.439*** | | |
| Observations | 21,824 | 21,824 | 21,824 | 21,824 |
| Adjusted- R^2 | 0.262 | 0.262 | 0.589 | 0.589 |

This table reports the two-stage least squares (2SLS) regression results of corporate cash holdings on predicted CEO ownership proxy variables and control variables. Columns (1) and (2) present the results of the first-stage of 2SLS regressions, in which the dependent variables are CEO_OWN_t and $CEO_OWN_SO_t$. Following Kim and Lu (2011) and Yost (2018), the instrumental variables (IVs) in the first-stage regressions are $CEO\ tax\ burden_t$ and $CEO\ tenure_t$. Shea's partial R^2 is a measure of the IV relevance (Shea, 1997). Kleibergen–Paap (KP) F-test is a test of the IV's exclusive condition. The KP LM test is a test of the underidentifying restriction. Columns (3) and (4) present the results of the second-stage of 2SLS regressions, in which the dependent variable is $Cash\ holdings_t$. The independent variables of interest are the predicted CEO ownership proxy variables obtained from the first-stage regressions. The control variables are the same as those in Eq. (1). All variables are defined in Appendix B (Table B.1). The coefficients of the control variables, year fixed effects, and Fama–French 48 industry fixed effects are suppressed for brevity in the respective columns. t -statistics based on standard errors clustered at the firm level are reported in brackets. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 5
Dynamic panel and fixed effects models.

| Variables | GMM | | Firm and year FE | | HDFE | |
|--------------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| CEO_OWN_t | 0.096*** [2.88] | | 0.020* [1.79] | | 0.009* [1.69] | |
| $CEO_OWN_SO_t$ | | 0.111*** [2.85] | | 0.022* [1.83] | | 0.010* [1.67] |
| $Cash\ holdings_{t-1}$ | 0.598*** [27.41] | 0.598*** [27.43] | | | | |
| Constant | 0.155*** [13.56] | 0.155*** [13.48] | 0.171*** [12.71] | 0.171*** [12.69] | 0.090*** [13.32] | 0.090*** [13.31] |
| AB test for AR(1) | -18.57*** | -18.57*** | | | | |
| AB test for AR(2) | 1.18 | 1.22 | | | | |
| Sargan test | 145.61*** | 144.96*** | | | | |
| Control variables | Yes | Yes | Yes | Yes | Yes | Yes |
| Firm fixed effects | – | – | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | No | No |
| Industry \times Year fixed effects | – | – | No | No | Yes | Yes |
| Observations | 20,833 | 20,833 | 26,409 | 26,409 | 26,217 | 26,217 |
| Adjusted- R^2 | – | – | 0.166 | 0.166 | 0.632 | 0.632 |

This table reports the GMM estimates of the dynamic cash model and the regression results of alternative fixed effects models, including firm and year fixed effects model and high-dimensional fixed effects (HDFE) model. The sample consists of 26,409 firm–year observations of U.S. firms over the sample period of 1992–2018 with required data for the regressions. The dependent variable is $Cash\ holdings_t$, and the independent variables of interest are CEO ownership (CEO_OWN_t and $CEO_OWN_SO_t$). Columns (1) and (2) report the GMM estimates of the dynamic cash model, where the dependent and explanatory variables are assumed to be endogenous and lagged values of dependent and explanatory variables are used to instrument them (Ozkan & Ozkan, 2004). AB test refers to the Arellano–Bond test for first (AR(1)) and second (AR(2)) order autocorrelations in residuals, respectively. Sargan test is a test of over-identifying restrictions, indicating whether the instruments and residuals are independent. Columns (3) and (4) present the results of the regressions with firm and year fixed effects. Columns (5) and (6) show the results of the regressions with the firm and interacted industry-year fixed effects. The control variables are the same as those in Eq. (1). All variables are defined in Appendix B (Table B.1). The coefficients of the control variables, firm fixed effects, year fixed effects, and interacted industry-year fixed effects are suppressed for brevity in the respective columns. t -statistics based on standard errors clustered at the firm level are reported in brackets. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 6
Alternative measures of cash holdings.

| Variables | <i>Excess cash holdings_t</i> | | <i>Industry-adjusted cash holdings_t</i> | |
|---------------------------------|---|--------------------|--|--------------------|
| | (1) | (2) | (3) | (4) |
| <i>CEO_OWN_t</i> | 0.087** [2.46] | | 0.116*** [3.47] | |
| <i>CEO_OWN_SO_t</i> | | 0.098** [2.52] | | 0.127*** [3.61] |
| Constant | 0.268*** [6.31] | 0.267*** [6.30] | 0.218*** [7.74] | 0.217*** [7.69] |
| Control variables | Yes | Yes | Yes | Yes |
| Industry fixed effects | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes |
| Observations | 11,271 | 11,271 | 25,408 | 25,408 |
| Adjusted- <i>R</i> ² | 0.238 | 0.238 | 0.239 | 0.239 |

This table presents the OLS regressions of alternative cash holdings on CEO ownership proxy variables and control variables. The sample consists of the S&P1500 firm-year observations over the sample period 1992–2018 with required data for the regressions. In columns (1)–(2), the dependent variable is *Excess cash holdings_t*, which is measured as the amount of cash above the predicted optimal level of cash reserves (Dittmar & Mahrt-Smith, 2007). We only focus on the firm-year observations with positive excess cash holdings. In columns (3)–(4), the dependent variable is *Industry-adjusted cash holdings_t*, which is measured as a firm's cash to total assets ratio minus the median of the cash to total assets ratios of all firms with the same 4-digit SIC industry codes (Haushalter et al., 2007). The independent variables of interest are *CEO_OWN_t* and *CEO_OWN_SO_t*. The control variables are the same as those reported in Eq. (1). All variables are defined in Appendix B (Table B.1). The coefficients of the control variables, year and Fama–French 48 industry fixed effects are suppressed for brevity in the respective columns. *t*-statistics based on standard errors clustered at the firm level are reported in brackets. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Table 7
Additional controls for corporate governance and CEO characteristics.

| Variables | (1) | (2) | (3) | (4) | (5) | (6) |
|---------------------------------------|---------------------|---------------------|---------------------|---------------------|--------------------|--------------------|
| <i>CEO_OWN_t</i> | 0.109** [2.32] | | 0.136** [2.51] | | 0.125* [1.74] | |
| <i>CEO_OWN_SO_t</i> | | 0.129*** [2.61] | | 0.148** [2.52] | | 0.136* [1.67] |
| <i>E-Index_t</i> | −0.004** [−2.55] | −0.004** [−2.53] | −0.004** [−2.44] | −0.004** [−2.44] | −0.001 [−0.72] | −0.001 [−0.73] |
| <i>TMI_t</i> | 0.042*** [2.94] | 0.042*** [2.94] | 0.046*** [3.30] | 0.046*** [3.26] | 0.042*** [2.62] | 0.042*** [2.59] |
| <i>Vega/TC_t</i> | | | −0.015 [−0.26] | −0.010 [−0.17] | −0.040 [−0.63] | −0.035 [−0.55] |
| <i>CEO age_t</i> | | | 0.004 [0.26] | 0.006 [0.34] | 0.000 [0.18] | 0.000 [0.29] |
| <i>CEO female_t</i> | | | 0.015 [1.46] | 0.015 [1.43] | 0.016 [1.26] | 0.016 [1.25] |
| <i>CEO duality_t</i> | | | −0.004 [−1.13] | −0.004 [−1.10] | −0.002 [−0.51] | −0.002 [−0.45] |
| <i>CEO education_t</i> | | | | | 0.001 [0.36] | 0.001 [0.31] |
| <i>CEO overconfidence_t</i> | | | | | 0.000 [0.03] | 0.000 [0.06] |
| Constant | 0.368*** [10.38] | 0.366*** [10.44] | 0.330*** [4.64] | 0.324*** [4.54] | 0.287*** [5.68] | 0.284*** [5.59] |
| Control variables | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 15,726 | 15,726 | 15,042 | 15,042 | 9,411 | 9,411 |
| Adjusted- <i>R</i> ² | 0.568 | 0.568 | 0.569 | 0.569 | 0.576 | 0.575 |

This table presents the OLS regressions of corporate cash holdings on CEO ownership proxy variables and additional control variables. The dependent variable is *Cash holdings_t*, and the independent variables of interest are *OWN_SO_t* and *OWN_t*. We add two corporate governance control variables: *E-Index_t* and *TMI_t*, and six control variables related to CEO: *Vega/TC_t*, *CEO age_t*, *CEO female_t*, *CEO duality_t*, *CEO education_t*, and *CEO overconfidence_t*. The other control variables are the same as those reported in Eq. (1). All variables are defined in Appendix B (Table B.1). The coefficients of the control variables, year fixed effects, and Fama–French 48 industry fixed effects are suppressed for brevity in the respective columns. *t*-statistics based on standard errors clustered at the firm level are reported in brackets. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

5. Mechanisms

Our analysis has shown that firms with higher CEO ownership hold more cash. In this section, we examine the plausible mechanisms through which CEO ownership affects cash holdings.

5.1. Firm-specific risk

The precautionary motive for holding cash suggests that firms with riskier cash flows, higher external financing costs, and better investment opportunities tend to hold more cash to hedge future cash flow uncertainty and reduce financial distress costs (Acharya et al., 2007; Bates et al., 2009; Opler et al., 1999). A survey study conducted by Graham and Harvey (2001) finds that corporate financial decisions are related to the evaluation of new investments, and firms are more likely to use firm-specific risk rather than individual project risk to evaluate new projects. The theoretical model of Riddick and Whited (2009) also shows a positive relationship between a firm's idiosyncratic risks and cash holdings. If firm ownership helps to align the interests between shareholders and CEOs by incentivizing CEOs to improve firm performance and mitigate firm-specific risk, CEOs with high firm ownership may choose to adopt a cash policy based on precautionary reasons. Following this vein, we expect that the impact of CEO ownership on cash holdings is more pronounced among firms with higher firm-specific risk.

Our first proxy for firm-specific risk is stock return volatility, *Return_Vol*, which captures a firm's idiosyncratic risk in the financial market. *Return_Vol* is defined as a firm's average monthly standard deviations of stock returns over a year, where the monthly standard deviation of stock returns is the sample standard deviation of daily stock returns within a month, multiplied by the number of trading days in the month (Rajgopal & Venkatachalam, 2011).¹¹ Our second proxy for firm-specific risk is cash flow volatility, *CF_Vol*, which captures a firm's operating uncertainty. *CF_Vol* is calculated as the standard deviation of the operating margin ratio, which is equal to operating cash flow divided by total sales, using annual data over three years (Bartram et al., 2011).¹² Similar to Bustamante and Frésard (2020), we define an indicator variable *D_high* which is equal to one if *Return_Vol* or *CF_Vol* is greater than its annual sample median, and zero otherwise, and an indicator variable *D_low* which is equal to one if *Return_Vol* or *CF_Vol* is less than its annual sample median, and zero otherwise. We then modify our baseline regression by replacing the *CEO ownership proxy* with the interaction terms between the *CEO ownership proxy* and two indicator variables:

$$\begin{aligned} \text{Cash holdings}_{i,t} = & \alpha + \beta_1 \text{CEO ownership}_{i,t} * D_high_t \\ & + \beta_1 \text{CEO ownership}_{i,t} * D_low_t \\ & + B \text{Control variables}_{i,t} + \mu_t + \theta_j + \epsilon_{i,t} \end{aligned} \quad (3)$$

Panel A of Table 8 reports the regression results. Columns (1)–(4) show that the estimated coefficients of interaction terms with *D_high* are positive and statistically significant, while the estimated coefficients of interaction terms with *D_low* are statistically insignificant. Our findings suggest that CEO ownership has a stronger impact on cash holdings when firms have higher firm-specific risk, supporting the precautionary motive for holding cash.

¹¹ Our results remain robust to the volatility of stock returns adjusted by the Fama and French (1993) three-factor model.

¹² Alternatively, we use five years of annual operating margins to calculate cash flow volatility; the results are the same. We also calculate cash flow volatility using the ratio of annual operating cash flows to total assets; the results remain robust.

5.2. External financing costs

According to the pecking order theory (Myers, 1984; Myers & Majluf, 1984), outside investors have less information about a firm's assets and investment opportunities compared to the firm's managers. The asymmetry of information between managers and outside investors results in a higher cost of external financing, and firms prefer to use internal cash rather than costly external financing. Firms may also forgo projects with positive net present value (NPV) if they do not have enough internal funds. To address the underinvestment problem in the future, firms may accumulate cash from operating revenue (Harford et al., 2008). If the precautionary motive drives the positive relationship between CEO ownership and cash holdings, we expect to find a stronger relationship when external financing costs are higher.

We use two proxies to measure a firm's external financing costs. The first proxy is the S&P credit rating of a firm, *Issuer Rating*, which indicates a forward-looking opinion about the credit quality of a firm's debt issue. Firms with a higher *Issuer Rating* have a lower debt financing cost. The second proxy is Whited and Wu's (2006) index, *WW-Index*, which measures a firm's external finance constraints. Firms with a higher *WW-Index* are expected to have a higher external financing cost. Similar to Eq. (3), we interact CEO ownership variables with *D_high* and *D_low*, which indicate whether *Issuer Rating* is above or below a BBB credit rating, or whether *WW-Index* is above or below its annual sample median. Results in columns (1) and (2) in Panel B of Table 8 show that the positive relationship between CEO ownership and cash holdings is stronger when firms have higher external financing costs. CEOs with higher firm ownership have higher incentives to improve shareholders' value, therefore they prefer to hold more precautionary cash reserves for financing positive NPV projects and preventing the underinvestment problem.

5.3. Corporate governance

Jensen (1986) argues that entrenched managers have greater preference for increasing firms' cash holdings so that they may pursue empire building and perquisite consumption at the expense of shareholders. Consistent with agency theory, Dittmar et al. (2003) show that firms hold more cash in countries with weaker corporate governance. Kalcheva and Lins (2007) also find that internationally firms with weaker shareholder protection hold more cash; however, they find no evidence that managerial agency costs outweigh the costs of underinvestment when country-level shareholder protection is weak. In Section 4.4, we have controlled for corporate governance using the *E-index* and the monitoring ownership of institutional investors, and the results show that the positive relationship between CEO ownership and cash holdings remains robust. In this section, we conduct a cross-sectional analysis and examine whether the positive relationship between CEO ownership and cash holdings is driven by the motive for managerial expropriation of cash holdings.

Previous studies suggest that firms with a higher *E-index* and lower institutional monitoring ownership are associated with weaker corporate governance and more agency problems (Bebchuk et al., 2009; Gompers et al., 2003). Similar to Eq. (3), we interact CEO ownership variables with *D_high* and *D_low*, which indicate whether *E-Index* and *TMI* are above or below their annual sample medians.¹³ The results in Panel C of Table 8 show that the positive relationship between CEO ownership and cash holdings only exists in firms with strong corporate governance measured by *E-Index*. In addition, the positive relationship

¹³ To be consistent with our tests in Table 7, we use *E-Index* and *TMI* as corporate governance proxies. We also use *G-Index*, *blockholder ownership*, and *institutional ownership* (Harford et al., 2008; Nikolov & Whited, 2014) as alternative corporate governance proxies. Untabulated tests show that our results remain robust.

Table 8
Differential impact of CEO ownership on cash holdings.

| Panel A. Firm-specific risk. | | | | |
|--|----------------------------------|--------------------|-----------------------------|--------------------|
| Variables | <i>Return_Vol_t</i> | | <i>CF_Vol_t</i> | |
| | (1) | (2) | (3) | (4) |
| <i>CEO_OWN_t</i> × <i>D_high</i> | 0.133*** [3.05] | | 0.202*** [4.42] | |
| <i>CEO_OWN_t</i> × <i>D_low</i> | 0.044 [1.05] | | 0.011 [0.32] | |
| <i>CEO_OWN_SO_t</i> × <i>D_high</i> | | 0.165*** [3.42] | | 0.229*** [4.64] |
| <i>CEO_OWN_SO_t</i> × <i>D_low</i> | | 0.042 [0.94] | | 0.013 [0.34] |
| Control variables | Yes | Yes | Yes | Yes |
| Industry fixed effects | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes |
| Test coefficient F-stat. | 3.41* | 4.24** | 16.12*** | 18.80*** |
| Observations | 21,754 | 21,754 | 26,387 | 26,387 |
| Adjusted- <i>R</i> ² | 0.599 | 0.599 | 0.587 | 0.587 |
| Panel B. External financing costs. | | | | |
| Variables | <i>Issuer_Rating_t</i> | | <i>WW-Index_t</i> | |
| | (1) | (2) | (3) | (4) |
| <i>CEO_OWN_t</i> × <i>D_high</i> | 0.134 [1.31] | | 0.088** [2.50] | |
| <i>CEO_OWN_t</i> × <i>D_low</i> | 0.094** [1.99] | | 0.078 [1.61] | |
| <i>CEO_OWN_SO_t</i> × <i>D_high</i> | | 0.104 [1.19] | | 0.112*** [2.70] |
| <i>CEO_OWN_SO_t</i> × <i>D_low</i> | | 0.105** [2.08] | | 0.096 [1.62] |
| Control variables | Yes | Yes | Yes | Yes |
| Industry fixed effects | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes |
| Test coefficient F-stat. | 16.12*** | 13.94*** | 42.98*** | 48.28*** |
| Observations | 5,459 | 5,459 | 26,226 | 26,226 |
| Adjusted- <i>R</i> ² | 0.429 | 0.429 | 0.577 | 0.587 |
| Panel C. Agency costs of managerial entrenchment. | | | | |
| Variables | <i>E-Index_t</i> | | <i>TMI_t</i> | |
| | (1) | (2) | (3) | (4) |
| <i>CEO_OWN_t</i> × <i>D_high</i> | 0.040 [0.62] | | 0.138** [2.51] | |
| <i>CEO_OWN_t</i> × <i>D_low</i> | 0.132** [2.11] | | 0.084** [2.37] | |
| <i>CEO_OWN_SO_t</i> × <i>D_high</i> | | 0.026 [0.36] | | 0.153** [2.56] |
| <i>CEO_OWN_SO_t</i> × <i>D_low</i> | | 0.166*** [2.60] | | 0.099*** [2.61] |
| Control variables | Yes | Yes | Yes | Yes |
| Industry fixed effects | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes |
| Test coefficient F-stat. | 19.61*** | 25.31*** | 50.95*** | 55.48*** |
| Observations | 10,400 | 10,400 | 26,203 | 26,203 |
| Adjusted- <i>R</i> ² | 0.581 | 0.581 | 0.587 | 0.587 |

This table presents the OLS regressions of cash holdings on the interactions between CEO ownership proxy variables and two indicator variables, *D_high* and *D_low*. *D_high* (*D_low*) is equal to one if the corresponding variable is greater than (less than) its annual sample median and zero otherwise. In Panel A, we employ stock return volatility (*Return_Vol*) and operating cash flow volatility (*CF_Vol*) as the proxies for firm-specific risk. In Panel B, we use a firm's credit rating, *Issuer_Rating*, and Whited and Wu (2006) external finance constraint index, *WW-Index*, as proxies for external financing costs. In Panel C, we adopt *E-Index*, and *TMI*, as proxies for corporate governance. We only report the coefficients on the interaction terms, and the F-statistic corresponding to a test of equality between interacted coefficients. The control variables are the same as those reported in Eq. (1). All variables are defined in Appendix B (Table B.1). The coefficients of the control variables, year fixed effects, and Fama–French 48 industry fixed effects are suppressed for brevity in the respective columns. *t*-statistics based on standard errors clustered at the firm level are reported in brackets. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

is stronger among firms with higher institutional monitoring ownership. Consistent with Bates et al. (2009), we find no evidence that high levels of CEO ownership cause entrenchment of managerial behaviors, in which CEOs are more likely to hoard cash reserves in the absence of effective corporate governance.

Overall, our three cross-sectional analyses suggest that the positive relationship between CEO ownership and cash holdings is more likely driven by the precautionary motive, rather than the private benefit motive for expropriating cash holdings.

6. Additional analyses

6.1. CEO ownership, firm investment, and payout decisions

To help us further distinguish the role of CEO ownership in corporate cash policy, we examine how CEO ownership affects the use of cash, specifically firm investment and payout decisions. Following Dittmar and Mahrt-Smith (2007), we use excess cash holdings (*Xcash*) as the amount of cash holdings above a predicted optimal level of cash reserves and focus on firms with positive excess cash holdings that are not essential for corporate operations and investment. Similar to Harford et al. (2008), we measure a firm's investment decisions using the changes in capital expenditures ($\Delta Capex$) and R&D expenses ($\Delta R\&D/Sales$), and measure a firm's payout policy using the changes in cash dividends per share of common stocks (ΔDiv) and open market repurchases of common stock ($\Delta Repurchases$). We regress the changes in investment or payout variables on CEO ownership, excess cash holdings, their interactions, and control variables. The control variables are the same as those in Eq. (1).¹⁴

Panel A of Table 9 shows that the interactions of CEO ownership and excess cash holdings are positively related to $\Delta Capex$ and $\Delta R\&D/Sales$, indicating that firms with high CEO ownership tend to invest more on capital expenditures and R&D when firms have more excess cash holdings. Our findings support the view that CEOs are incentivized to invest more cash in future growth opportunities. Our result is consistent with Hobdari (2008), who finds that investment of employee-owned firms is positively associated with internal funds. Panel B of Table 9 shows that the coefficients of the interaction terms between CEO ownership and excess cash holdings are all statistically insignificant, suggesting that firms with high CEO ownership do not have a higher payout ratio when excess cash holding is high. These findings indicate that CEO ownership aligns CEOs interests to shareholders' interests and encourages CEOs to retain large cash reserves as precautionary savings, rather than distributing cash to shareholders (Chen & Chuang, 2009).

6.2. CEO ownership and the value of cash

Our cross-sectional analyses in Section 5 suggest that CEOs with higher firm ownership hold more cash as a precautionary strategy to hedge against potential firm risks and mitigate the underinvestment problem. However, firms also incur costs of holding cash, such as a low rate of return on these liquid assets (Opler et al., 1999) and high capital gain tax on the interest of cash reserves (Faulkender & Wang, 2006). To understand the impact of CEO ownership on the cost-benefit trade-offs, we further investigate how CEO ownership affects the market perceived value of cash holdings. When CEO ownership enhances the alignment of CEOs' and shareholders' interests, a firm's cash hoarding behavior driven by the precautionary motive should improve the efficiency of the firm's cash policy and create value for shareholders. As such, the marginal value of cash should be positively associated with CEO ownership.

To estimate the value of one additional dollar of cash holdings associated with CEO ownership, we extend Faulkender and Wang's (2006) valuation model by adding the interactions between CEO ownership proxies and the change in cash holdings:

$$r_{i,t} - R_{i,t}^B = \alpha + \beta_1 CEO\ ownership_{i,t} \times \Delta C_{i,t} + \beta_2 CEO\ ownership_{i,t} + \beta_3 \Delta C_{i,t} + \beta_4 \Delta E_{i,t} + \beta_5 \Delta N A_{i,t} + \beta_6 \Delta R\&D_{i,t} + \beta_7 \Delta I_{i,t} + \beta_8 \Delta D_{i,t} + \beta_9 N F_{i,t} + \beta_{10} C_{i,t-1} + \beta_{11} C_{i,t-1} \times \Delta C_{i,t} + \beta_{12} L_{i,t} + \beta_{13} L_{i,t} \times \Delta C_{i,t} + \mu_t + \theta_j + \epsilon_{i,t} \quad (4)$$

where *i* is firm index, *t* is year index, *j* is industry index; $r_{i,t}$ is firm *i*'s stock return during fiscal year *t*; $R_{i,t}^B$ is firm *i*'s benchmark portfolio return at year *t* and the benchmark portfolio is one of the 25 Fama and French (1993) value-weighted portfolios formed on size and book-to-market ratio; *CEO ownership*_{*i,t*} is either *CEO_OWN* or *CEO_OWN_SO*; Δ indicates a change in the corresponding variables over fiscal year *t*; and $C_{i,t}$ is cash and marketable securities. Our control variables include earnings before interest and extraordinary items ($E_{i,t}$), total assets net of cash ($NA_{i,t}$), research and development expenses ($R\&D_{i,t}$), interest expenses ($I_{i,t}$), common dividends ($D_{i,t}$), net financing proceeds ($NF_{i,t}$), and market leverage ($L_{i,t}$). We normalize all the accounting variables in Eq. (4) by the one-year lagged market value of equity, apart from $L_{i,t}$. μ_t is the year fixed effect and θ_j is the Fama–French 48 industry fixed effect.

The independent variable of interest is the interaction term: *CEO ownership*_{*i,t*} \times $\Delta C_{i,t}$. Since both the dependent and independent variables are normalized by the one-year lagged market value of equity, the estimated coefficient β_3 can be interpreted as the marginal value of cash, that is, the dollar change in shareholder wealth for a one-dollar increase in corporate cash holdings associated with CEO ownership. The estimated coefficient β_1 represents the direct effect of CEO ownership on the value of corporate cash holdings.

Columns (1) and (2) of Table 10 show that the coefficients of the interaction terms are positive and statistically significant at the 10% and 5% levels. β_3 is equal to 1.241 in column (1) and 1.655 in column (2). The results report that a one-standard-deviation increase in *CEO_OWN* is associated with a \$0.07 (= 0.056 * 1.241) increase in the marginal value of cash, and a one-standard-deviation increase in *CEO_OWN_SO* is associated with a \$0.09 (= 0.056 * 1.655) increase in the marginal value of cash. These results suggest that CEO ownership has a positive impact on the value of corporate cash holdings.

Finally, we examine the impact of CEO ownership on the value of cash across firms within different cash regimes. We follow Halford et al. (2017) and classify firms into three *ex-post* cash regimes. Firms are classified into the raising cash regime if they issue equity and do not pay dividends in fiscal year *t*. Conversely, firms are classified into the distributing cash regime if they distribute cash to shareholders and do not issue equity in fiscal year *t*. Additionally, firms are classified into the servicing debt regime if their market leverage ratios are in the top decile distribution of firms at the beginning of fiscal year *t* and do not have cash raising or distributing activities in fiscal year *t*. Columns (3)–(8) of Table 10 show that the impact of CEO ownership on the value of cash remains positive and statistically significant for firms in the raising cash regime only. In the raising cash regime, CEOs with high firm ownership are motivated to increase shareholder value by increasing cash reserves for maintaining the ability to finance positive NPV projects and avoiding the underinvestment problem due to the costly external financing. As shown in Section 6.1, CEOs with high ownership choose to hold cash for the precautionary motive rather than distributing cash as dividends, share repurchases, or debt payments. Consequently, CEO ownership is not positively related to the value of cash in the distributing cash and servicing debt regimes. Our findings are consistent with the view that firms with high CEO ownership accumulate cash for the precautionary demand of future investment.

¹⁴ We drop CAPEX, R&D/Sales, or Dividends from the control variables if it is the dependent variable in the regressions.

Table 9
CEO ownership, investment decisions, and payout policy.

| Panel A. Investment decisions. | | | | |
|---------------------------------------|----------------------|--------------------|------------------------|---------------------|
| Variables | $\Delta Capex_t$ | | $\Delta R\&D/Sales_t$ | |
| | (1) | (2) | (3) | (4) |
| $CEO_OWN_t \times Xcash_t$ | 0.079** [2.03] | | 0.167*** [3.53] | |
| CEO_OWN_t | -0.012 [-1.14] | | -0.003 [-0.54] | |
| $CEO_OWN_{SO_t} \times Xcash_t$ | | 0.096** [2.36] | | 0.154*** [3.12] |
| $CEO_OWN_{SO_t}$ | | -0.013 [-1.16] | | 0.000 [0.08] |
| $Xcash_t$ | 0.012*** [3.65] | 0.012*** [3.53] | -0.018** [-2.53] | -0.018** [-2.43] |
| Control variables | Yes | Yes | Yes | Yes |
| Industry fixed effects | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes |
| Observations | 10,558 | 10,558 | 10,569 | 10,569 |
| Adjusted- R^2 | 0.146 | 0.147 | 0.065 | 0.064 |
| Panel B. Payout decisions. | | | | |
| Variables | $\Delta Dividends_t$ | | $\Delta Repurchases_t$ | |
| | (1) | (2) | (3) | (4) |
| $CEO_OWN_t \times Xcash_t$ | -0.057 [-1.44] | | 0.015 [0.19] | |
| CEO_OWN_t | 0.011 [1.45] | | -0.012 [-0.97] | |
| $CEO_OWN_{SO_t} \times Xcash_t$ | | -0.063 [-1.52] | | -0.004 [-0.05] |
| $CEO_OWN_{SO_t}$ | | 0.012 [1.41] | | -0.014 [-1.10] |
| $Xcash_t$ | 0.001 [0.27] | 0.001 [0.31] | -0.014 [-1.53] | -0.013 [-1.45] |
| Control variables | Yes | Yes | Yes | Yes |
| Industry fixed effects | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes |
| Observations | 10,563 | 10,563 | 9,707 | 9,707 |
| Adjusted- R^2 | 0.032 | 0.032 | 0.025 | 0.025 |

This table presents the OLS regressions of the changes in firm investment or payout variables on CEO ownership, excess cash holdings, the interactions of the two variables, and control variables. We only report the coefficients on the interaction terms. The control variables in Panel A are the same as those reported in Eq. (1) without $CAPEX_t$ in columns (1) and (2) and without $R\&D/Sales_t$ in columns (3) and (4). The control variables in Panel B are the same as those reported in Eq. (1) without $Dividends_t$. All variables are defined in Appendix B (Table B.1). The coefficients of the control variables, year fixed effects, and Fama–French 48 industry fixed effects are suppressed for brevity in the respective columns. t -statistics based on standard errors clustered at the firm level are reported in brackets. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

7. Conclusions

In this study, we investigate the relationship between CEO equity ownership and corporate cash policy using a sample of S&P 1500 firms from 1992 to 2018. Our analysis reveals a monotonically positive relationship between CEO ownership and corporate cash holdings, which remains robust after controlling for endogeneity using PSM, 2SLS, GMM, and HDFE identification methods. We further examine the potential mechanisms underlying the positive relationship and show that the positive relationship is more prominent for firms with higher firm-specific risk and larger external financing costs, suggesting that CEOs hoard cash due to the precautionary saving motive. We do not find evidence that agency issues are a significant factor driving the relationship between CEO ownership and cash holdings.

We also find that firms with higher CEO ownership tend to accumulate cash for the precautionary demand of future investment, rather than distributing cash as dividends, share repurchases, or debt payments. Furthermore, shareholders' perceived value of cash increases with CEO ownership, which further supports the view that shareholders

place a positive value on high levels of cash holdings in the context of growing investment prospects. In addition, we find that the positive impact of CEO ownership on the value of cash is significant only for firms in the raising cash regime, indicating that CEOs with high firm ownership are motivated to increase shareholder value by increasing cash reserves for maintaining the ability to finance positive NPV projects and avoiding underinvestment problems due to costly external financing.

Our study contributes to the expanding body of literature on cash holdings and corporate governance by clarifying how CEO ownership affects the incentives of firms to hold cash. Our results provide compelling evidence and support the notion of the precautionary motive, where CEO ownership aligns with incentives to hoard cash as a safety net. Additionally, our findings emphasize the dominant role played by the CEO in determining corporate cash policy among top executives. Overall, our study provides valuable insights for understanding the determinants of corporate cash policies and the role of CEO ownership in shaping these policies.

Table 10
CEO ownership and the value of cash.

| Variables | Total sample | | Raising cash | | Distributing cash | | Servicing debt | |
|------------------------------------|--------------|-----------|--------------|-----------|-------------------|-----------|----------------|-----------|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $CEO_OWN_t \times \Delta C_t$ | 1.241* | | 2.920*** | | -0.040 | | -1.818 | |
| | [1.92] | | [3.85] | | [-0.05] | | [-0.68] | |
| CEO_OWN_t | -0.139*** | | 0.057 | | -0.076 | | -0.203 | |
| | [-2.66] | | [0.22] | | [-1.55] | | [-0.26] | |
| $CEO_OWN_SO_t \times \Delta C_t$ | | 1.655** | | 2.823*** | | 0.356 | | -3.034 |
| | | [2.45] | | [3.78] | | [0.40] | | [-1.12] |
| $CEO_OWN_SO_t$ | | -0.117** | | 0.288 | | -0.071 | | 0.168 |
| | | [-2.02] | | [0.99] | | [-1.31] | | [0.21] |
| ΔC_t | 2.170*** | 2.162*** | 2.286*** | 2.277*** | 1.429*** | 1.417*** | 1.042 | 1.087 |
| | [20.31] | [20.30] | [9.01] | [8.97] | [12.07] | [12.01] | [1.11] | [1.15] |
| ΔE_t | 0.663*** | 0.663*** | 0.594*** | 0.596*** | 0.609*** | 0.609*** | 0.332*** | 0.331*** |
| | [20.26] | [20.25] | [6.04] | [6.05] | [15.56] | [15.56] | [2.64] | [2.64] |
| ΔNA_t | 0.192*** | 0.192*** | 0.254*** | 0.254*** | 0.204*** | 0.204*** | 0.118 | 0.118 |
| | [10.84] | [10.87] | [4.30] | [4.30] | [10.28] | [10.27] | [1.50] | [1.48] |
| $\Delta R\&D_t$ | 1.445*** | 1.438*** | 1.162 | 1.173 | 0.671 | 0.668 | 5.190 | 5.278 |
| | [3.71] | [3.69] | [1.16] | [1.17] | [1.38] | [1.38] | [1.55] | [1.59] |
| ΔI_t | -3.193*** | -3.191*** | -2.233* | -2.208* | -3.425*** | -3.428*** | -1.462 | -1.437 |
| | [-7.17] | [-7.16] | [-1.68] | [-1.66] | [-6.98] | [-6.98] | [-0.81] | [-0.79] |
| ΔD_t | 0.793* | 0.791* | -2.206 | -2.197 | 1.648*** | 1.649*** | -1.344 | -1.402 |
| | [1.72] | [1.72] | [-0.90] | [-0.89] | [3.95] | [3.95] | [-0.33] | [-0.35] |
| NF_t | 0.432*** | 0.431*** | 0.792*** | 0.790*** | 0.248*** | 0.248*** | 0.477*** | 0.466*** |
| | [14.66] | [14.65] | [7.60] | [7.56] | [7.71] | [7.70] | [3.17] | [3.12] |
| C_{t-1} | -0.503*** | -0.502*** | -1.042*** | -1.039*** | -0.338*** | -0.337*** | -3.652*** | -3.659*** |
| | [-25.54] | [-25.51] | [-11.84] | [-11.78] | [-18.30] | [-18.31] | [-8.30] | [-8.33] |
| $C_{t-1} \times \Delta C_t$ | -0.134*** | -0.135*** | 0.097 | 0.094 | -0.280*** | -0.280*** | -0.127 | -0.126 |
| | [-3.57] | [-3.60] | [0.80] | [0.78] | [-6.91] | [-6.90] | [-0.67] | [-0.67] |
| L_t | -1.113*** | -1.117*** | -1.484** | -1.469** | -0.344 | -0.349 | -2.097 | -2.062 |
| | [-4.35] | [-4.37] | [-1.99] | [-1.97] | [-1.18] | [-1.21] | [-1.49] | [-1.48] |
| $L_t \times \Delta C_t$ | -2.936*** | -2.937*** | -2.868*** | -2.838*** | -1.616*** | -1.605*** | 0.912 | 0.857 |
| | [-10.73] | [-10.75] | [-4.20] | [-4.15] | [-5.22] | [-5.19] | [0.57] | [0.54] |
| Constant | 0.014 | 0.012 | 0.413*** | 0.409*** | -0.040 | -0.041 | 1.847*** | 1.851*** |
| | [0.36] | [0.30] | [2.94] | [2.92] | [-1.06] | [-1.08] | [8.41] | [8.43] |
| Industry fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 23,215 | 23,215 | 2,356 | 2,356 | 18,520 | 18,520 | 306 | 306 |
| Adjusted-R ² | 0.212 | 0.212 | 0.295 | 0.295 | 0.168 | 0.168 | 0.533 | 0.533 |

This table presents the OLS regressions of firm excess returns on the change in cash holdings, CEO ownership proxy variables, the interaction of the prior two variables, and control variables. The main sample consists of the S&P1500 firm-year observations over the sample period 1992–2018 with required data for the regressions. The dependent variable is $r_{i,t} - R_{i,t}^B$, the annual excess stock return relative to the 25 Fama and French (1993) size and book-to-market portfolios. Δ indicates the change in the corresponding variable from year $t-1$ to t . All variables are defined in Appendix B (Table B.1). The coefficients of the year and Fama–French 48 industry fixed effects are suppressed for brevity in the respective columns. t -statistics based on standard errors clustered at the firm level are reported in brackets. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

CRedit authorship contribution statement

Wenyi Sun: Conceptualization, Methodology, Software, Data curation, Writing – original draft. **Chao Yin:** Conceptualization, Data curation, Validation, Writing – review & editing. **Yeqin Zeng:** Conceptualization, Supervision, Visualization, Validation, Writing – review & editing.

Appendix A. Measure of CEO ownership

CEO_OWN_SO is the fraction of stock and options deltas held by a CEO to the firm’s total delta associated with all outstanding common stocks and stock options. Since the delta of one share of stocks is equal to one:

$$CEO_OWN_SO = \frac{CEO\ Shares + CEO\ Option\ Delta}{Total\ Outstanding\ Shares + Total\ Option\ Delta}$$

where $CEO\ Shares$ is the number of common stocks held by a CEO; $CEO\ Option\ Delta$ is the delta of all stock options held by a CEO, estimated by the procedure outlined in Appendix B of Edmans et al. (2009); $Total\ Outstanding\ Shares$ is the number of outstanding common shares issued by a firm; and $Total\ Option\ Delta$ is the delta of a firm’s outstanding

stock options, calculated by the following equation:

$$Total\ Option\ Delta = \Delta EX_{avg} \times optex + \Delta UNEX_{ave} \times optosey$$

where ΔEX_{avg} is the annual average delta of exercisable stock options across all executives (including the CEO) covered by ExecuComp, estimated by the method in Appendix B of Edmans et al. (2009); $optex$ is the number of exercisable stock options at the year end, and zero if missing; $\Delta UNEX_{ave}$ is the annual average delta of non-exercisable stock options across all executives (including the CEO) covered by ExecuComp, estimated by the method in Appendix B of Edmans et al. (2009); and $optosey$ is the number of stock options granted to date that has not been exercised or cancelled, and are non-exercisable at the year end, and zero if missing. Following Kim and Lu (2011) and Edmans et al. (2009), $Total\ Option\ Delta$ is equal to $\max\{Total\ Option\ Delta, Firm\ Exercisable\ Option\ Delta\}$.

Appendix B. Variable definition

This table provides variable definitions and corresponding data sources. CRSP refers to the Centre for Research in Security Prices, ISS refers to the Institutional Shareholder Services (formerly RiskMetrics), s34 files refer to the Thomson Reuters 13F Database, and FF refers to Kenneth R. French’s data library.

Table B.1

Variable definitions.

This table provides variable definitions and corresponding data sources. CRSP refers to the Centre for Research in Security Prices, ISS refers to the Institutional Shareholder Services (formerly RiskMetrics), s34 files refer to the Thomson Reuters 13F Database, and FF refers to [Kenneth R. French's data library](#).

| Variable | Definition | Source |
|---------------------------------|--|-----------|
| Cash holdings | Cash plus marketable securities, normalized by total assets (Bates et al., 2009). | Compustat |
| CEO_OWN | The ratio of outstanding common stocks held by a CEO to the firm's total outstanding common stocks (Kim & Lu, 2011). | ExecuComp |
| CEO_OWN_SO | The ratio of delta of common stocks and stock options held by a CEO to the firm's total delta associated with all outstanding common stocks and stock options (Kim & Lu, 2011). | ExecuComp |
| CEO_OWN_05 | Equals CEO_OWN if $0 < CEO_OWN < 5\%$, and equals 5% if $CEO_OWN \geq 5\%$ (Kim & Lu, 2011; Opler et al., 1999). | ExecuComp |
| CEO_OWN_0525 | Equals 0 if $CEO_OWN \leq 5\%$, equals CEO_OWN minus 5% if $5\% < CEO_OWN < 25\%$, and equals 20% if $CEO_OWN \geq 25\%$ (Kim & Lu, 2011; Opler et al., 1999). | ExecuComp |
| CEO_OWN_25 | Equals 0 if $CEO_OWN \leq 25\%$, and equals CEO_OWN minus 25% if $CEO_OWN > 25\%$ (Kim & Lu, 2011; Opler et al., 1999). | ExecuComp |
| CEO_OWN_SO_05 | Equals CEO_OWN_SO if $0 < CEO_OWN_SO < 5\%$, and equals 5% if $CEO_OWN_SO \geq 5\%$ (Kim & Lu, 2011; Opler et al., 1999). | ExecuComp |
| CEO_OWN_SO_0525 | Equals 0 if $CEO_OWN_SO \leq 5\%$, equals CEO_OWN_SO minus 5% if $5\% < CEO_OWN_SO < 25\%$, and equals 20% if $CEO_OWN_SO \geq 25\%$ (Kim & Lu, 2011; Opler et al., 1999). | ExecuComp |
| CEO_OWN_SO_25 | Equals 0 if $CEO_OWN_SO \leq 25\%$, and equals CEO_OWN_SO minus 25% if $CEO_OWN_SO > 25\%$ (Kim & Lu, 2011; Opler et al., 1999). | ExecuComp |
| Top5_OWN | The common stock ownership of the five executives with the highest compensation. | ExecuComp |
| Top5_OWN_SO | The ownership of the five executives with the highest compensation, where the ownership is defined the same as CEO_OWN_SO. | ExecuComp |
| Top4_OWN | The common stock ownership of the four executives (excluding CEOs) with the highest compensation. | ExecuComp |
| Top4_OWN_SO | The ownership of the four executives (excluding CEOs) with the highest compensation, where the ownership is defined the same as CEO_OWN_SO. | ExecuComp |
| Size | The natural logarithm of total assets (Bates et al., 2009). | Compustat |
| CF | Earnings before interest, tax, depreciation and amortization minus interests, tax, and common dividends, normalized by total assets (Bates et al., 2009). | Compustat |
| MTB | A ratio of the book value of total assets minus the book value of equity plus the market value of equity to the book value of total assets (Bates et al., 2009). | Compustat |
| NWC | Net working capital minus cash and marketable securities, normalized by total assets (Bates et al., 2009). | Compustat |
| CAPEX | Capital expenditures, normalized by total assets (Bates et al., 2009). | Compustat |
| R&D/Sales | A ratio of research and development expenses to total sales. R&D/Sales is equal to zero if research and development expenses are missing (Bates et al., 2009). | Compustat |
| Acquisitions | Acquisition expenditures, normalized by total assets (Bates et al., 2009). | Compustat |
| Dividends | An indicator variable, equals to one if a firm pays a positive common dividend, and zero otherwise (Bates et al., 2009). | Compustat |
| Sigma | The average of the standard deviations of CF over ten years for firms with the same 2-digit SIC codes (Bates et al., 2009). | Compustat |
| Leverage | Total debt, normalized by total assets (Bates et al., 2009). | Compustat |
| Firm age | The natural logarithm of the number of years since a firm's IPO as reported in CRSP (Kim & Lu, 2011). | CRSP |
| Vega/TC | The ratio of vega of shares and stock options held by a CEO to total compensation, where total compensation includes salary, bonus, restricted stock and option grants, long-term incentive payouts, and any other compensation (Liu & Mauer, 2011). | ExecuComp |
| CEO age | The age of a CEO as reported in the ExecuComp database (Liu & Mauer, 2011). | ExecuComp |
| CEO female | An indicator variable, equals to one if a CEO is female, and zero otherwise. | ExecuComp |
| CEO duality | An indicator variable, equals to one if a CEO is the chairman of the board, and zero otherwise (Jenter & Lewellen, 2015). | BoardEx |
| CEO education, | An index of a CEO's education level, equals to one if the CEO has a high-school or diploma certificate, two if the CEO has a bachelor degree, three if the CEO has a master degree, and four if the CEO has a PhD degree (Custódio & Metzger, 2014). | BoardEx |
| CEO overconfidence, | An indicator variable, equals to one if a CEO at least once during our sample period holds an option until the year of expiration, even though the stock option is at least 67% in-the-money during its final year; and zero otherwise (Malmendier & Tate, 2005). | ExecuComp |
| CEO tenure | The number of years that a CEO has served in the position as reported in the ExecuComp database (Liu & Mauer, 2011). | ExecuComp |
| CEO tax burden | A CEO's tax liability arising from the sale of the vested stock holdings, scaled by the stock equivalent value from the CEO's holdings of stocks and stock options (Yost, 2018). | ExecuComp |
| E-Index | A corporate governance index, composed of the six most important provisions in G-index (Bebchuk et al., 2009). | ISS |
| TMI | The ownership of institutional investors whose holding value in a firm ranked as the top 10% of the stocks in their portfolios (Fich et al., 2015). | s34 files |
| Xcash | The amount of cash held above a predicted optimal level of cash reserves, which is not needed for a firm's investment or operations (Dittmar & Mahrt-Smith, 2007). | Compustat |
| Industry-adjusted cash holdings | Cash to total assets ratio minus the median of the ratios across the firms with the same 4-digit SIC codes (Haushalter et al., 2007). | Compustat |
| Return_Vol | The average monthly standard deviation of a firm's stock returns over one year, where the monthly standard deviation of the stock returns refers to the sample standard deviation of daily stock returns within a month, multiplied by the number of trading days in the month (Rajgopal & Venkatachalam, 2011). | CRSP |
| CF_Vol | Operating cash flow volatility, defined as the standard deviation of operating margins (operating cash flow divided by total assets) using 3 years of annual data (Bartram et al., 2011). | Compustat |
| Issuer Rating | The Standard and Poor's credit rating of a firm. | Compustat |
| WW-Index | $WW-Index = -0.091 * CF - 0.062 * Dividends + 0.021 * (Lont-term\ debt/total\ assets) - 0.044 * Size + 0.102 * (3-digit\ industry\ sales\ growth) - 0.035 * (sales\ growth)$ (Whited & Wu, 2006). | Compustat |

(continued on next page)

Table B.1 (continued).

| Variable | Definition | Source |
|------------------------|---|-------------------------|
| D_{high} | An indicator variable, equals to one if <i>Return_Vol</i> , <i>CF_Vol</i> , <i>WW-Index</i> , <i>E-Index</i> , or <i>TMI</i> is higher than the corresponding annual sample median, and zero otherwise. D_{high} is also equal to one if <i>Issuer Rating</i> is BBB or higher (investment grade), and zero otherwise (Saretto & Tookes, 2013). | |
| D_{low} | An indicator variable, equals to one when <i>Return_Vol</i> , <i>CF_Vol</i> , <i>WW-Index</i> , <i>E-Index</i> , or <i>TMI</i> is lower than the corresponding annual sample median, and zero otherwise. D_{low} is also equal to one if <i>Issuer Rating</i> is lower than BBB, and zero otherwise (Saretto & Tookes, 2013). | |
| $\Delta Capex_t$ | Change in CAPEX from fiscal year $t-1$ to year t (Harford et al., 2008). | Compustat |
| $\Delta R\&D/Sales_t$ | Change in R&D/Sales from fiscal year $t-1$ to year t (Harford et al., 2008). | Compustat |
| ΔDiv_t | Change in the ratio of cash dividend payment to total assets from fiscal year $t-1$ to year t (Harford et al., 2008). | CRSP |
| $\Delta Repurchases_t$ | Change in the ratio of stock repurchases to total assets from fiscal year $t-1$ to year t (Harford et al., 2008). | CRSP |
| $r_t - R_t^B$ | Excess stock returns with the benchmark portfolios defined as Fama–French 25 portfolios formed on size and book-to-market (Faulkender & Wang, 2006). | CRSP, Compustat, and FF |
| MV_t | Market value of equity, defined as the number of shares outstanding multiplied by stock price (Faulkender & Wang, 2006). | Compustat |
| C_t | Cash plus marketable securities, normalized by MV at the start of fiscal year t (Faulkender & Wang, 2006). | Compustat |
| ΔC_t | Change in cash plus marketable securities from fiscal year $t-1$ to year t , normalized by MV at the start of fiscal year t (Faulkender & Wang, 2006). | Compustat |
| ΔE_t | Change in earnings from fiscal year $t-1$ to year t , normalized by MV at the start of fiscal year t . Earnings are calculated as earnings before extraordinary items plus interest, deferred tax credits, and investment tax credits (Faulkender & Wang, 2006). | Compustat |
| ΔNA_t | Change in net assets from fiscal year $t-1$ to year t , normalized by MV at the start of fiscal year t . Net assets are calculated as total assets minus cash holdings (Faulkender & Wang, 2006). | Compustat |
| $\Delta R\&D_t$ | Change in R&D expenditure from fiscal year $t-1$ to year t , normalized by MV at the start of fiscal year t (Faulkender & Wang, 2006). | Compustat |
| ΔI_t | Change in interest expenses from fiscal year $t-1$ to year t , normalized by MV at the start of fiscal year t (Faulkender & Wang, 2006). | Compustat |
| ΔD_t | Change in total common share dividends from fiscal year $t-1$ to year t , normalized by MV at the start of fiscal year t (Faulkender & Wang, 2006). | Compustat |
| NF_t | Net financing proceeds, defined as equity issuance minus repurchases, plus debt issuance minus debt redemption, normalized by MV at the start of fiscal year t (Faulkender & Wang, 2006). | Compustat |
| L_t | Total debt divided by the sum of total debt and MV (Faulkender & Wang, 2006). | Compustat |

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