Rev Quant Finan Acc
https://doi.org/10.1007/s11156-017-0684-3

ORIGINAL RESEARCH

Parent-subsidiary investment layers and the value of corporate cash holdings

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Abstract Our study investigates whether agency costs arising from organizational structure in terms of the number of investment layers which connect the parent firm and its lowest-tiered subsidiaries within the corporate pyramid are associated with the value of cash holdings. Using a sample of Taiwanese publicly traded firms, we find that a change of a dollar in cash holdings is associated with less than a dollar change in market value. In line with our expectation, we find that the marginal value of cash decreases with the number of investment layers, supporting the agency theory of excess cash holdings. We also find that the negative association between the number of layers and the value of cash holdings is stronger for firms with high deviation between cash flow and voting rights and for family-controlled firms.

Keywords Corporate pyramid · Layers · Value of cash holdings · Agency costs

JEL Classification L20 · G30 · G32

1 Introduction

Corporate liquidity management has received considerable attention from academia and practitioners in recent years due to dramatic increases in the amount of cash held by firms. In the United States, for example, the ratio of cash holdings to total assets increased from 10.5% in 1980 to 23.2% in 2006 (Bates et al. 2009). Chang (2015) also finds that the same cash holding ratio doubles from 2003 to 2013 for Taiwan firms. Cash holdings can be a double-edged sword that is able to harm as well as benefit investors. Specifically, cash

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Published online: 18 December 2017

holdings can create value when external financing becomes costly (Myers 1977). They can also act as a buffer against cash flow uncertainty, or be used for risky corporate investment (Bates et al. 2009). Alternatively, cash holdings have a low return on asset investment (Dittmar et al. 2003), and if not properly monitored, they can promote suboptimal investment and private-benefits extraction behaviors, thereby destroying firm value (Jensen 1986; Harford 1999).

This study investigates the market value of corporate cash holdings in connection with the pyramidal investment structure. In the pyramidal structure, the parent firms frequently control multiple subsidiaries through an indirect ownership structure (e.g., father–son–grandson relationship), consisting of a parent company on top and successive layers of subsidiaries below (Hoyle et al. 2011). Pyramidal structures can also function as substitutes for imperfect external capital markets, especially in cases where market institutions are less developed (Claessens et al. 2002; Almeida and Wolfenzon 2006a, b; Khanna and Yafeh 2007). We capture an important feature of corporate pyramids by measuring the number of investment layers connecting the parent firm to its lowest-tiered subsidiary and investigate whether the value of a firm's cash holdings is associated with the number of investment layers.[1]

Ours is the first study to examine whether the value of cash holdings at the consolidated level is also affected by the parent-subsidiary investment structure.[2] We argue that the agency costs of cash holdings for pyramid firms are likely to be significant. Theories predict that establishing a long span of pyramidal layers allows the parent firm to leverage up its control relative to its ownership of the bottom-layered subsidiaries (e.g., La Porta et al. 1999; Claessens et al. 2002) and produces incentives for controlling shareholders in order to pursue rent-seeking behaviors, such as cross-subsidiary subsidizing and expropriation from minority shareholders (Johnson et al. 2000; Bebchuk et al. 2000; Bae et al. 2002; Morck et al. 2005). A large amount of cash holdings may tempt controlling shareholders and management to engage in wasteful expenditures and suboptimal investments. Harford (1999) finds that cash-rich firms make suboptimal acquisitions. Opler et al. (1999) and Lamont (1997) find that cash-rich firms are associated with suboptimal capital expenditures and tend to cross-subsidize poorly performing projects. Since the long span of the investment layers gives rise to the deviation between the controlling parent's cash flow rights and the voting rights over the lower-layered subsidiaries, entrenchment effects set in and thus more severe agency conflicts between controlling shareholders and minority shareholders are anticipated. To the extent that a pyramid firm can enjoy the benefits of holding cash without being subject to the scrutiny of external capital markets, it is more likely that its management and controlling shareholders will spend cash assets on self-serving projects at the expense of minority shareholders, leading to the agency problem of

[1] Figure 1 maps the organizational structure of Asus Corp., a famous multinational corporation in Taiwan, based on "Quanxi Business Operation Report," Asus Corp.'s 2009 annual report, as follows: ASUS Corp. (TW), at layer zero, the top of the investment structure, indirectly controls the lowest-tier firm, Tubesonic Technology Ltd. (China), at layer six through Pegatron Co. (layer one), HuaWei Investing Corp. (layer two), Kinsus Interconnect Technology Corp. (layer three), Kinsus Holding (Samoa) (layer four), and Kinsus Holding Ltd. (Cayman) (layer five). Thus, the number of investment layers for Asus Corp is six.

[2] Kusnadi (2011) uses a sample of firms listed in Malaysia and Singapore and finds that pyramid firms with a single leadership structure (i.e. the CEO and the Chairman of the Board are the same person) hold more cash than those with more effective governance, consistent with the notion that entrenched managers of pyramid firms have more discretion to hoard cash reserves. However, Kusnadi (2011) uses only an indicator variable to capture the pyramidal structure of ultimate family controllers. They do not include detailed features such as the number of investment layers and the deviation between cash flow rights and voting rights.

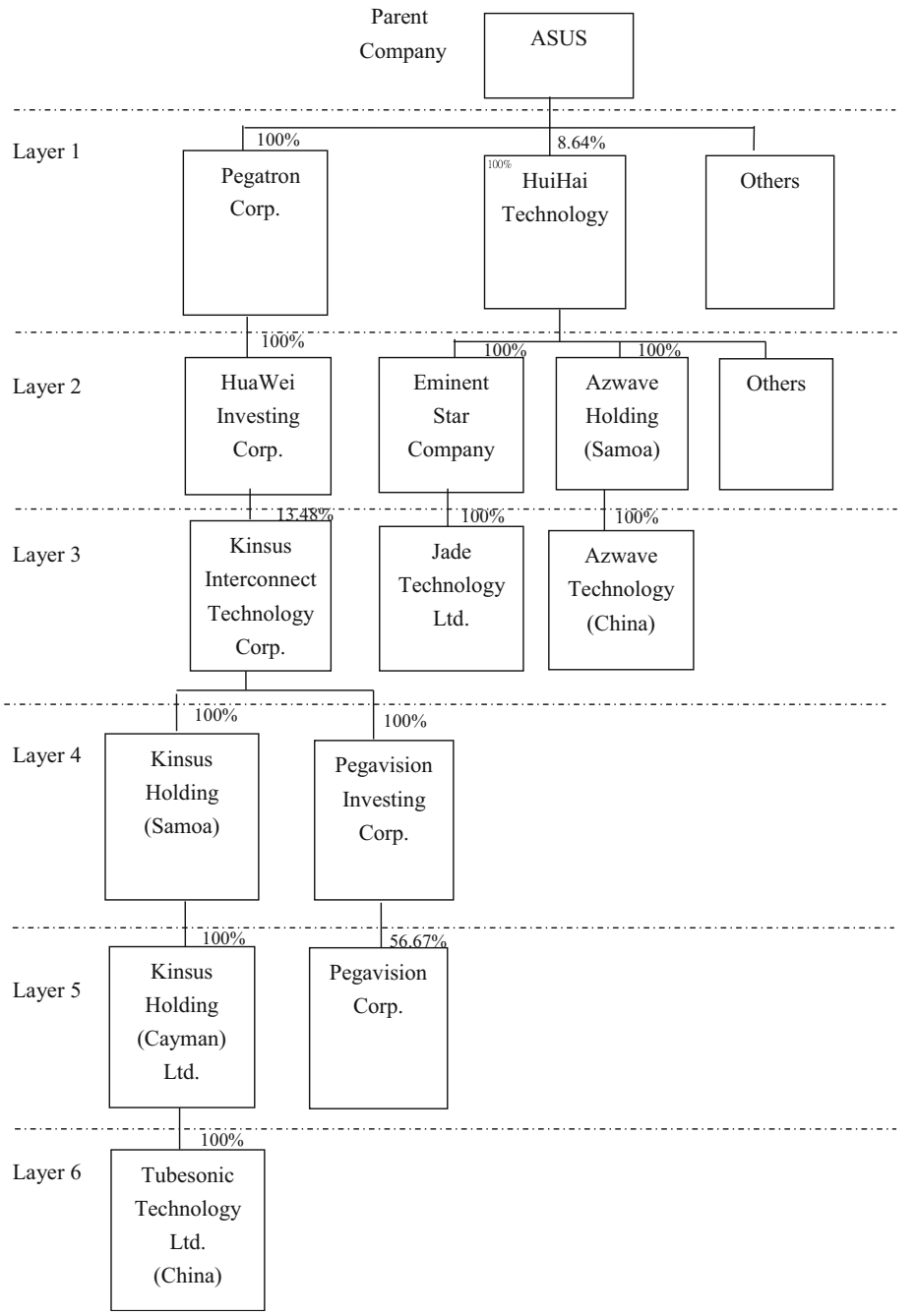

Fig. 1 Investment structure of Asus corporation. The figure is based on Asus annual financial reports 2009

cash holding (Jensen 1986; Stulz 1990). For pyramidal firms, holding more cash could actually harm firm value. Thus, we expect a negative association between the number of investment layers and the value of cash holdings.

To investigate the hypothesis regarding the number of investment layers within a corporate pyramid vis-à-vis the value of cash holdings, we use a sample of publicly traded, non-financial Taiwanese firms during the period 2000–2013, drawn from the TEJ database. We focus on Taiwan, where publicly traded firms are required to disclose information on all of their subsidiaries according to "Criteria Governing Preparation of Affiliation Reports, Consolidated Business Reports and Consolidated Financial Statements of Affiliation Enterprises" (hereafter CGPAR). As such, the data for studying layers at all levels are readily available, unlike in the U.S and other developed economies, where the data on subsidiaries (layers) are limited. The availability of CGPAR allows us to measure the number of layers in a corporate investment structure and to identify the locations of subsidiaries. Specifically, in order to measure the span of investment layers, we identify all the layers connecting the parent company to the lowest-tiered subsidiaries and measure the number of layers as the number of layers connecting the parent company to the lowest-tiered subsidiaries.[3]

We find that firms with a large number of layers within a pyramidal structure are associated with a lower value of cash holdings than firms with a small number of layers, consistent with the agency theory of cash holdings. Moreover, the negative association is more pronounced for multi-layered firms with higher levels of deviation between cash flow rights and voting rights and for multi-layered firms which are controlled by family owners, consistent with the same theory, which further holds that deviation between cash flow rights and voting rights and the presence of family control are common indicators of potentially severe agency conflict between controlling and non-controlling shareholders.

This paper contributes to the literature in the following ways. First, our study addresses the trade-off between benefits and costs associated with pyramidal firms' holding of cash and cash equivalents. Though the costs and benefits of cash holdings have been well documented in prior literature, it remains unclear to what extent pyramidal firms bear the agency cost of cash holdings while also enjoying the benefits of internal capital markets. Second, this study contributes to an understanding of how investors perceive the value of cash holdings in such common investment structures in emerging markets. Third, prior studies examine various determinants of the value of cash holdings such as corporate governance, financial constraints, and growth opportunities without further investigating whether the value of cash holdings at the consolidated level is also affected by the parent-subsidiary structure. Our study, in contrast, takes a close look at the internal organizational structure to help us better understand the influence of fewer organizational levels within pyramidal firms on the value of cash holdings.

The remainder of the paper proceeds as follows. Section 2 provides a review of the relevant literature and Sect. 3 develops our hypotheses. Section 4 outlines the research design. Section 5 describes the sample selection and reports the results. Section 6 presents additional analyses, and we conclude in Sect. 7.

[3] For firms with multiple chains in investment structures, we focus on the longest chain, i.e., the chain with the largest number of intermediate layers. All pyramidal firms can be handled in the same manner and processed using the TEJ database.

2 Literature review

2.1 Agency costs of cash holdings

Myers and Rajan (1998) argue that cash reserves are anonymous and transportable, and easily to be accessed by management and/or controlling shareholders at their discretion with little scrutiny. Cash reserves can be turned into private benefits at lower cost than other assets. Hoarding cash assets accelerates tunneling problems, in which managers extract pecuniary private benefits via methods such as expropriation and excessive perquisites (e.g., Jensen and Meckling 1976; Jensen 1986). In addition, managers have a tendency to overinvest, expanding their "empire," because doing so increases their power and compensation but such overinvestment may not be in the best interest of shareholders (Jensen 1986; Faulkender and Wang 2006). When firms have excess cash, managers can control and make use of more resources without ensuring the monitoring of capital markets that occurs when a firm has to raise more capital (Jensen 1986). Thus, hoarding cash assets exacerbates agency costs by aggravating overinvestment, which reduces profitability and destroys firm value.

Consistent with the agency cost of cash hoarding, Harford (1999) demonstrates that firms with large cash holdings overinvest in acquisitions and that acquisitions by cash-rich firms are more likely to be value decreasing. Harford et al. (2008) further extend the findings by showing that entrenched managers of poorly governed firms dissipate cash through acquisitions and capital expenditures. Dittmar and Mahrt-Smith (2007) find that $1.00 of cash in a poorly governed firm is valued at only $0.42 to $0.88 while good governance approximately doubles this value. Lee and Lee (2009) document a negative association between firm value and cash levels in firms with weaker internal governance structure because investors are concerned with value destroying projects pursued by managers of these firms holding excess cash. Liu and Mauer (2011) investigate the value of cash from the perspective of bondholders. They find that CEO vega has a negative effect on the marginal value of cash to shareholders, suggesting that excess cash mitigates the bondholders' risk from CEO risk-taking incentives induced by high CEO vega compensation.

From the financial reporting perspective, Louis et al. (2012) find that accounting conservatism that involves timely recognition of losses and delayed recognition of gains helps reduce agency costs of cash assets, especially overinvestment.

Using the worldwide country sample, Kalcheva and Lins (2007) document that the combination of weak country-level shareholder protection and strong firm-level managerial entrenchment reduces the value of cash held by non-US firms. Pinkowitz et al. (2006) also present evidence indicating that a marginal value of a dollar cash decreases with the quality of country-level corporate governance (e.g., corruption index, anti-director index). In contrast, Fresard and Salva (2010) find that value of excess cash holdings is higher for foreign firms cross listed in the US than for their domestic peer firms. They further show that the higher value of excess cash for cross-listing firms stems from the strength of the legal environment, disclosure requirements, and the information-monitoring pressure associated with the US listing. With a cross-country data, Iskandar-Datta and Jia (2014) demonstrate the greater sensitivity of investment to excess cash for firms in countries with a weak legal regime, reflecting managerial empire building behaviors when firms have excess cash while in a weak legal regime.

In sum, prior studies shows that investors discount the value of cash held by firms whose managers appear to be entrenched while the internal or external protection against expropriation is poor. A substantial source of value destruction associated with weak governance can be traced to investors' discounting cash holdings (Fresard and Salva 2010)).

2.2 Precautionary benefits of cash holdings

Another strand of the literature provides evidence for the precautionary benefits of holding cash. Specifically, holding liquid assets as a buffer helps firms cope with the volatility of cash flows and adverse cash flow shocks. Consistent with this argument, Opler et al. (1999) document that firms tend to hold more liquid assets if their industry's average cash flow volatility is higher and if they have restricted access to capital markets. Almeida et al. (2004) find that the sensitivity of cash holdings to cash flows is more pronounced for firms with larger gap between external and internal financing costs. Arslan-Ayaydin et al. (2014) document that firms that combine low leverage with high cash balance prior to the Asia financial crisis can maintain their capital investment better during the crisis period. Bates et al. (2009) present evidence that the positive trend of the average cash-to-assets ratio in the U.S. over their sample period of 1980–2006 is correlated with firms' cash flows becoming more volatile and cash being more valuable for firms with higher cash flow volatility and R&D expenditures. Hill et al. (2014) find an inverse relation between cash level and lobby expense, consistent with the argument that political connections help reduce the uncertainty of future cash flows and therefore politically-connected firms do not need to hold as much cash for precautionary reasons.

In addition, holding liquid assets as a safe margin helps firms to take investment opportunities when external capital is more costly than internal capital (Myers and Majluf 1984). Since managers are better informed about their own firm's prospects than are external capital providers, managers will try to time the issuance of shares and to sell shares at an inflated price. External capital providers who anticipate such misvaluation will withhold capital or raise the cost of capital to protect prices. As the costs of external capital are higher than the costs of internal capital, firms are inclined to use internal capital (Myers and Majluf 1984; Ascioglu et al. 2008). Firms that have low levels of internal capital, and/or whose investment projects are not profitable enough to cover the costs of external capital, often pass up investment opportunities, resulting in underinvestment. Thus, internal cash holdings enable a firm to finance profitable projects that the external capital market would not be willing to fund. Consistent with this concept, Nguyen et al. (2017) find that diversified firms are able to hold less precautionary cash since they are able to finance investment opportunities using internal generated capital. Yu et al. (2015) find that firms with more banking relationships are likely to be less constrained to access external capital, and thus tend to hold less cash. Faulkender and Wang (2006) document that a long-term bond rating or commercial paper rating decreases the cost of debt financing and thus reduces the precautionary benefits of holding cash. Their findings support the notion that the marginal value of cash decreases with better access to capital markets. Denis and Sibilkov (2010) find that constrained firms with higher levels of investment hold more cash and that the association between investment and value is stronger for constrained firms than for unconstrained firms. These findings imply that higher cash holdings allow constrained firms to undertake value-increasing projects without external financing when such projects might otherwise be bypassed. Likewise, Brown and Petersen (2011) focus especially on potential value-constructing activities-R&D investment and find that firms that

are most likely to face financial frictions use cash holdings to smooth R&D investment. For example, young firms used cash holdings to reduce the volatility in R&D by around 75% during the 1998–2002 boom and decline in equity issues.

Prior studies also show that CEO characteristics can affect the value of cash holdings. Huang-Meier et al. (2016) find that firms with optimistic CEOs hold less cash reserves for precautionary reasons. Lins et al. (2010) further distinguish the sources of corporate liquidity. Using a survey of chief financial officers from 29 countries, they investigate when firms use lines of credit versus cash reserves. They find that cash reserves guard against future cash flow shocks in bad times while lines of credit provide firms with options to take future business opportunities that are available in good times.

3 Hypothesis development

3.1 The number of investment layers and the value of cash holdings

In this study, we expect that the value of cash holdings varies with the number of investment layers. Prior studies suggest that more investment layers leads to more agency costs between controlling shareholders and outsiders. The pyramid structure is viewed as a mechanism to preserve private benefits for the ultimate controlling shareholders because they exercise their control power in excess of their cash flow rights (Claessens et al. 2002). Establishing a long span of pyramidal layers incentivizes the controlling parent to pursue rent-seeking behaviors through transferring resources out of the bottom-layered subsidiaries (Johnson et al. 2000; Bebchuk et al. 2000; Bae et al. 2002; Morck et al. 2005). In addition to the self-serving and rent-seeking behaviors discussed above, the controlling parent might use the firm's cash holdings to finance projects with a negative present value of cash flows and/or subsidize unprofitable subsidiaries. When internal cash is reallocated within a firm in such a way that the most profitable projects do not have priority, the internal capital market becomes inefficient. Access to an internal capital market is value-added only for firms with low levels of information problems (Lundstrum 2003). Wei and Zhang (2008) find that the divergence between large shareholders' control rights and cash flow rights is positively related to the sensitivity of investment to cash flows, suggesting that too much cash in the hands of entrenched managers and controlling shareholders is likely to lead to overinvestment problems. Thus, we argue that the number of investment layers is negatively associated with the value of cash.[4] Our first hypothesis is specified in the null form as follows:

H1 Ceteris paribus, the number of investment layers within a pyramidal structure is negatively associated with the value of cash holdings.

[4] However, we are not able to rule out the possibility that the value of cash holdings may increase along with the number of investment layers for the following reason. A firm with a large number of investment layers has higher agency costs, which can make it difficult for external funding providers to assess and monitor its operations. Consistent with this argument, Hsu et al. (2015) find that the number of investment layers for FDI (foreign direct investment) in China increases agency costs, which reduces creditors' willingness to provide capital. Chan and Hsu (2013) directly document a positive association between the number of investment layers and the cost of debt. Myers and Majluf (1984) argue that external finance is costly and cash provides a safe buffer. Corporate cash holdings enable firms to make additional investments without raising external capital, helping companies avoid high financing costs. Thus, as external finance tends to be more expensive for pyramid firms due to their organizational complexity, each additional dollar of cash holdings by such firms may have a higher value.

3.2 Effects of deviation

As noted by Myers and Rajan (1998), liquid assets such as cash can be easily diverted into private benefits by entrenched managers or controlling shareholders at a lower cost than can other types of assets. Pinkowitz et al. (2006 p. 2725) therefore suggest that cash "represents a promising opportunity to investigate the implications of agency theories." We argue that if the parent firm does not hold 100% of the equity shares of the lower-tiered subsidiaries, adding more layers to the pyramid enables the controlling shareholders of the parent firm to leverage up their control rights disproportionately to their cash flow rights over subsidiaries on the lower tiers (La Porta et al. 1999; Claessens et al. 2002). A high level of deviation between cash flow rights and voting rights gives insiders private benefits while bearing a relatively small proportion of the related cash flow consequences (e.g., Claessens et al. 2000; Fan and Wong 2002). Thus agency costs arising from the inherent separation of cash flow rights and voting rights within the pyramidal structure increase the controlling parent's incentive to expropriate other shareholders and creditors (Bebchuk et al. 2000) and to hide expropriation behaviors via less transparent financial reporting. As such, Hsu and Liu (2016) find that corporate earnings quality is negatively associated with the number of investment layers when the investment structure has high agency problems as measured by high deviation between voting rights and cash flow rights.

Such agency problems also affect the value of cash holdings to shareholders; specifically, controlling owners who obtain effective control over the use of cash take rent-seeking actions, such as quicker dissipation of corporate cash holdings (Harford et al. 2008). In the face of such severe agency conflicts, the capital market will value firms' cash holdings less since cash holdings represent a fungible resource that can be easily diverted. Based on this discuss, we form our second hypothesis as follows, stated in the alternative form.

H2 Ceteris paribus, the negative association between the number of investment layers and the value of cash holdings is more (less) pronounced in firms with high (low) levels of deviation between cash flow rights and voting rights.

3.3 Effects of family control

Studies of family firms in the U.S. suggest that family control/ownership has a positive effect on firm value, reduces the cost of debt financing (Anderson and Reeb 2003; Anderson et al. 2003), and enhances earnings quality and voluntary disclosures (Ali et al. 2007; Wang 2006; Chen et al. 2008). These studies attribute such findings to family owners' long investment horizon and concern for their firms' reputations, as well as better alignment between ownership and management, such that, compared to non-family firms, family firms face fewer agency problems between shareholders and management, as described in Jensen and Meckling (1976).

However, while family firms do not have severe shareholder-manager agency costs, they are characterized by agency problems arising from conflicts between controlling and non-controlling shareholders. Such agency problems are even more pronounced in Taiwan, where firms operate in an environment marked by the absence of effective audit committees, low institutional ownership, relatively weak investor protection, and inactive markets for corporate control, compared to the U.S. (e.g., La Porta et al. 1999; Claessens et al. 2000).

La Porta et al. (1999) suggest that controlling shareholders tend to extract rent at the expense of other shareholders and creditors. Claessens et al. (2002) also argue that controlling family owners are more likely to engage in opportunistic activities and to divert resources to themselves than are shareholders of widely held corporations. Based on a sample of Taiwanese firms, Yeh and Woidtke (2005) find that firms in which board members are closely affiliated with the controlling family are characterized as poorly governed with strongly entrenched control, and thus are valued less. Hsu and Liu (2016) also document that the negative association between earnings quality and the number of investment layers is more pronounced for family firms than for other firms,

Overall, prior empirical results are consistent with the entrenchment perspective, which posits that the ownership and control concentrated in family firms exacerbates agency conflict between controlling and non-controlling shareholders and increases the risk of expropriation of non-controlling shareholders' wealth.

Dual-class share arrangements are prohibited in Taiwan; however, controlling families of Taiwanese firms tend to increase their control via pyramidal structures and cross-holding. In addition, Claessens et al. (2000) find that around 80% of the Taiwan-listed firms in their sample are managed by members of the controlling families who, because of their substantial portions of their firms' shares, are able to elect board members and appoint managers of their preference, leading to increased agency problems between controlling and non-controlling shareholders (e.g., also Claessens et al. 2002; Fan and Wong 2005; Yeh and Woidtke 2005). Therefore, we argue that if family firms have more investment layers, their controlling owners may have more incentives as well as greater ability to become entrenched, as compared to non-family firms. Thus, the cash held by family firms is subject to more severe agency costs, resulting in lower value to shareholders. Thus, we form the hypothesis in its alternative form as follows.

H3 Ceteris paribus, the negative association between the number of investment layers and the value of cash holdings is more pronounced for family-controlled firms.

4 Research design

4.1 Propensity-score matching

As the number of investment layers is a firm's choice, the possibility of endogeneity, in which omitted determinants lead to a longer span of pyramidal firms, may also affect corporate cash reserves. For instance, as controlling shareholders of firms which have more severe agency problems create multiple-layered pyramidal structures to increase their control so that it exceeds their cash flow rights, severe agency problems can also incentivize them to extract rent through the misuse of cash. To address a sample selection bias due to observable differences between firms with a large number of investment layers and firms with a small number of investment layers (Rosenbaum 2002), we use propensity score matching to build a matched sample from short-layered firms and compare it to long-layered firms which are similar along all other observable characteristics.

First, we generate a propensity score using the following probit regression that models the likelihood of a firm's pyramiding a large number of investment layers:

$$P(DLARGE_{it}) = \beta_0 + \beta_1 SIZE_{it} + \beta_2 MB_{it} + \beta_3 BLEV_{it} + \beta_4 CAPEX_{it} + \beta_5 INVESTEE_{it} + \beta_6 TAXH_{it} + \beta_7 DUALITY_{it} + \beta_8 INSIDEB_{it} + \beta_9 INSIDEM_{it} + \beta_{10} INST_{it} + \beta_{11} FOREIGN_{INSTit} + \beta_{12} INDE_{it} + \beta_{13} PLEDGE_{it} + \beta_{14} BSIZE_{it} + INDSTRYdummy + YEARdummy + \varepsilon_{it} \quad (1)$$

where *DLARGE* is an indicator variable which equals one if the number of layers equals or is larger than three (as the mean value is 3.24), and zero otherwise. We consider two sets of variables to capture a firm's decision to build more investment layers. The first set of variables is related to firm characteristics: size (*SIZE*, the natural logarithm of a firm's total net assets), growth opportunities (*MB*, measured by the ratio of the book value of debt plus the market value of equity to total assets), leverage (*BLEV*, book leverage as the ratio of total debts to total assets), capital expenditure (*CAPEX*, the ratio of the capital expenditure to net assets), the number of investees (*INVESTEE*, taking the log), and the number of investees located in a tax haven (*TAXH*, taking the log). The second set of variables captures the firms' governance dimension: duality (*DUALITY*, an indicator variable which equals one if the CEO also serves as chairman of the board and zero otherwise), director ownership (*INSIDEB*), management ownership (*INSIDEM*), institutional ownership (*INST*), foreign institutional ownership (*FOREIGN_INST*), the percentage of independent directors serving on the board (*INDE*), the percentage of equity shares used by block-holders as a pledge for financing (*PLEDGE*), and the number of board directors (*BSIZE*, taking the log). Year and industry fixed effects are incorporated. The variable definitions are presented in the "Appendix" section.

We then match firms with a large number of investment layers (i.e., the number is greater than 3) with firms in the same year with a small number of investment layers (i.e., the number is smaller than 3), employing the closest propensity-score. We impose a 3% tolerance level on the maximum propensity score distance. By doing so, we match approximately 90% of long-layered firms with short-layered firms and create a pseudo random matched sample which is similar to the treatment sample except for the number of investment layers.

4.2 Valuation of cash holding tests

Faulkender and Wang's (2006) find that one additional dollar in cash holdings is associated with less than one dollar change in market value when firms have larger cash holdings and higher leverage. Our study is to examine whether, in addition to corporate financial policy, the number of investment layers can reduce the marginal market value of cash holdings. Thus, we extend Faulkender and Wang's (2006) model by including the number of investment layers (*DLARGE*) as an additional explanatory variable and interacting changes in cash holdings ($\Delta CASH$), with *DLARGE*. More specifically, we use the following model:

$$
\begin{aligned}
ABNORMAL\_RET_{it} = {} & \beta_0 + \beta_1 \frac{\Delta CASH_{it}}{M_{it-1}} + \beta_2 DLARGE_{it} + \beta_3 DLARGE_{it} \times \frac{\Delta CASH_{it}}{M_{it-1}} \\
& + \beta_4 \frac{\Delta EARN_{it}}{M_{it-1}} + \beta_5 \frac{\Delta NetAssets_{it}}{M_{it-1}} + \beta_6 \frac{\Delta RD_{it}}{M_{it-1}} + \beta_7 \frac{\Delta INTEST_{it}}{M_{it-1}} \\
& + \beta_8 \frac{\Delta DIVIDEND_{it}}{M_{it-1}} + \beta_9 \frac{NF_{it}}{M_{it-1}} + \beta_{10} \frac{CASH_{it-1}}{M_{it-1}} + \beta_{11} \frac{CASH_{it-1}}{M_{it-1}} \\
& \times \frac{\Delta CASH_{it}}{M_{it-1}} + \beta_{12} MLEV_{it} + \beta_{13} MLEV_{it} \times \frac{\Delta CASH_{it}}{M_{it-1}} \\
& + INDSTRYdummy + YEARdummy + \varepsilon_{it}
\end{aligned}
\tag{2}
$$

In Eq. (2), the dependent variable is the abnormal return for firm i in fiscal year t, calculated as the stock return for firm i over fiscal year t minus the annual returns of a benchmark portfolio based on Fama and French's size and book-to-market matched portfolio returns.[5] $\Delta CASH$ is the change in cash holding for the year. *DLARGE* is an indicator which equals 1 if the number of layers equals 3 or is greater than 3 and 0 otherwise, where the number of layers is calculated as the number of layers connecting the parent to its lowest-tiered subsidiary along its longest vertical investment chain.

The coefficient (β_2) on the variable *DLARGE* can be interpreted as the difference of the abnormal returns between firms with a large number of investment layers and a short number of investment layers. Our main variable of interest is the coefficient (β_3), the effect of investment layers on the association between abnormal returns and changes in cash holdings. We expect β_3 to be negative if our expectation for H1 is supported that a large number of investment layers can reduce the market value of a change in cash holdings.

Following Faulkender and Wang (2006), we also control for variables that could be correlated with abnormal returns and cash holdings affect excess returns: changes in a firm's profitability (*EARN*, earnings before interest and taxes) and changes in investment policy on asset mix (*NetAssets*, total assets minus cash) and research and development expenditures (*RD*). The control variables for financing activities that affect risk and cash holdings include changes in interest payments (*INTEREST*), dividend payouts (*DIVIDEND*), the firm's net financing during fiscal year t (*NF*), cash holdings in the prior year ($CASH_{i,t-1}$) and its interaction with change in cash holdings ($CASH_{i,t-1} \times \Delta CASH_{i,t}$), and market leverage (*MLEV*) and its interaction with change in cash holdings ($MLEV_{i,t} \times \Delta CASH_{i,t}$). The "Appendix" section contains detailed variable definitions. We scale the independent variables by firm i's market value of equity in year $t - 1 (M_{i,t-1})$. We also control for industry characteristics and overall macroeconomic conditions over time by incorporating industry and year indicators and winsorize the continuous variables at the 1 and 99% levels to reduce the effect of outliers.

[5] To calculate the benchmark portfolio's value-weighted return, we use 25 Fama and French (1993) portfolios based on size and book-to-market. In particular, for each fiscal year, we assign each firm into one of 25 portfolios based on its size and book-to-market ratio.The benchmark portfolios are designed to offset the expected return component of stock i due to its size and book-to-market ratio at the beginning of the fiscal year. As noted in Dittmar and Mahrt-Smith (2007), specification of the returns in excess of the benchmark portfolio controls for risk and discount rate, which may affect both cash holdings and stock returns other than cash holdings and their interaction.

4.3 Valuation of cash holding tests with respect to the deviation between cash flow rights and voting rights

To further investigate whether the association between the value of cash holdings and the number of investment layers varies with the deviation between cash flow rights and voting rights, we create an indicator (*DEV*) which equals one if firms have any successive layers of subsidiary ownership below 50% and zero otherwise and run the following ordinary least squares (OLS) regression.

$$\begin{aligned} ABNORMAL\_RET_{it} = {} & \beta_0 + \beta_1 \frac{\Delta CASH_{it}}{M_{it-1}} + \beta_2 DLARGE_{it} + \beta_3 DEV_{it} + \beta_4 DLARGE_{it} \times \frac{\Delta CASH_{it}}{M_{it-1}} \\ & + \beta_5 DEV_{it} \times \frac{\Delta CASH_{it}}{M_{it-1}} + \beta_6 DLARGE_{it} \times DEV_{it} + \beta_7 DLARGE_{it} \times DEV_{it} \\ & \times \frac{\Delta CASH_{it}}{M_{it-1}} + \beta_8 \frac{\Delta EARN_{it}}{M_{it-1}} + \beta_9 \frac{\Delta NetAssets_{it}}{M_{it-1}} + \beta_{10} \frac{\Delta RD_{it}}{M_{it-1}} \\ & + \beta_{11} \frac{\Delta INTEST_{it}}{M_{it-1}} + \beta_{12} \frac{\Delta DIVIDEND_{it}}{M_{it-1}} + \beta_{13} \frac{NF_{it}}{M_{it-1}} + \beta_{14} \frac{CASH_{it-1}}{M_{it-1}} \\ & + \beta_{15} \frac{CASH_{it-1}}{M_{it-1}} \times \frac{\Delta CASH_{it}}{M_{it-1}} + \beta_{16} MLEV_{it} + \beta_{17} MLEV_{it} \times \frac{\Delta CASH_{it}}{M_{it-1}} \\ & + INDSTRYdummy + YEARdummy + \varepsilon_{it} \end{aligned} \tag{3}$$

All other variables are as discussed in Eq. (2). We predict that the association between the value of cash holdings and the number of investment layers varies systematically with the ownership of subsidiaries held by the controlling shareholders (through the parent company). In particular, H2 predicts that the negative association between the value of cash holdings and the number of layers becomes more (less) pronounced in firms with high (low) deviation between cash flow rights and voting rights (H2: $\beta_7 < 0$). To make it easier to explain this argument, we also partition the full sample into firms for which the ownership of any successive layers of subsidiaries is below 50% (i.e., the high deviation subsample) or not (i.e., the low deviation subsample) and run Eq. (2) for each subsample.

4.4 Valuation of cash holding tests with respect to the presence of family control

To test H3, whether the association between the value of cash holdings and the number of investment layers varies systematically with the presence of family control, we incorporate an indicator (*FF*) which equals one for family firms and zero otherwise, where family firms are defined as those in which the family members either hold more than 50% of the directorship, hold more control rights than necessary to main control over the company, or hold the position of CEO or the board of directors. We run the ordinary least squares (OLS) regression as follows.

$$
\begin{aligned}
ABNORMAL\_RET_{it} = {} & \beta_0 + \beta_1 \frac{\Delta CASH_{it}}{M_{it-1}} + \beta_2 DLARGE_{it} + \beta_3 FF_{it} + \beta_4 DLARGE_{it} \times \frac{\Delta CASH_{it}}{M_{it-1}} \\
& + \beta_5 FF_{it} \times \frac{\Delta CASH_{it}}{M_{it-1}} + \beta_6 DLARGE_{it} \times FF_{it} + \beta_7 DLARGE_{it} \times FF_{it} \\
& \times \frac{\Delta CASH_{it}}{M_{it-1}} + \beta_8 \frac{\Delta EARN_{it}}{M_{it-1}} + \beta_9 \frac{\Delta NetAssets_{it}}{M_{it-1}} + \beta_{10} \frac{\Delta RD_{it}}{M_{it-1}} \\
& + \beta_{11} \frac{\Delta INTEST_{it}}{M_{it-1}} + \beta_{12} \frac{\Delta DIVIDEND_{it}}{M_{it-1}} + \beta_{13} \frac{NF_{it}}{M_{it-1}} + \beta_{14} \frac{CASH_{it-1}}{M_{it-1}} \\
& + \beta_{15} \frac{CASH_{it-1}}{M_{it-1}} \times \frac{\Delta CASH_{it}}{M_{it-1}} + \beta_{16} MLEV_{it} + \beta_{17} MLEV_{it} \times \frac{\Delta CASH_{it}}{M_{it-1}} \\
& + INDSTRYdummy + YEARdummy + \varepsilon_{it}
\end{aligned}
\tag{4}
$$

H3 predicts that the negative association between the value of cash holdings and the number of investment layers is stronger for family firms than for non-family firms (H3: $\beta_7 < 0$).

5 Sample, summary statistics, and results

5.1 Sample selection

Using the *Taiwan Economic Journal* (TEJ) database, we focus on firms that are currently listed on the Taiwan Stock Exchange (TSE) and over-the-counter market (OTC). The number of initial observations in the 2000–2013 period excluding financial firms, which have unique industry characteristics and capital structures, is 12,195. We eliminate firm-year observations for which the market value of equity is negative and net assets are negative. We exclude firms with missing values for the variables needed in the tests, leading to a final sample of 6561 observations.

5.2 Propensity-score matching and descriptive statistics

Panel A of Table 1 presents the results of the probit model used to estimate the propensity scores. Our analyses suggest that smaller firms, firms with a lower market-to-book ratio, firms with more capital expenditures, more complex firms in terms of the number of investees, and firms with more investees located in tax havens are more likely to establish a large number of investment layers. Among the corporate governance variables, we also find that firms whose CEOs also serve as the chair of the board of directors are more likely to construct a longer span of investment layers.

We then impose a 3% tolerance level on the maximum propensity score distance and match approximately 90% of large-layer firms with small-layer firms. We obtain a propensity-score matched sample of 2696 firm-year observations, of which 1348 are firms with a large number of investment layers (number $\geq$ 3) and 1348 are firms with a small number of investment layers (number $<$ 3). As demonstrated in Panel B of Table 1, the differences in the two sets of variables (firm characteristics and governance characteristics) between the treatment and the matched firms are insignificant according to the paired *t*-tests, suggesting that the propensity-score matching procedure is effective in forming a pseudo-random matched sample that is similar to the treatment sample in terms of firm and

Table 1 Propensity score matching

	(1)	
	DLAYER	*t*-Stat
Panel A. Probit model (DLARGE = 1 if the number of layers > 3 and 0 otherwise)		
CONSTANT		
SIZE	− 2.073	(− 5.77)***
MB	0.080	(3.00)**
BLEV	− 0.006	(− 0.16)
CAPEX	0.544	(3.64)***
INVESTEE	1.080	(2.80)**
TAXTH	0.872	(15.23)***
DUALITY	0.487	(11.62)***
INSIDEB	0.013	(0.27)
INSIDEM	0.527	(2.53)*
INST	1.313	(1.41)
FOREIGN_INST	0.106	(0.72)
INDE	0.448	(1.92)
PLEDGE	− 0.149	(− 0.93)
BSIZE	0.131	(1.26)
Year and industry fixed effects:	Yes	
N		6561
Adj. R^2		35.06%

	Large group *DLARGE* = 1 Mean	Small group *DLARGE* = 0 Mean	DIFF	*t* test
Panel B: Descriptive statistics for the large group and the matched small group				
SIZE	16.53	16.44	0.09	1.01
MB	1.21	1.04	0.17	1.38
BLEV	0.45	0.46	− 0.01	− 0.15
CAPEX	0.06	0.05	0.01	0.23
DUALITY	0.29	0.00	0.29	1.01
INSIDEB	0.18	0.15	0.03	1.45
INSIDEM	0.01	0.00	0.01	0.24
INST	0.43	0.42	0.01	0.61
FOREIGN_INST	0.14	0.11	0.03	0.13
INDE	0.10	0.08	0.02	1.24
PLEDGE	0.15	0.17	− 0.02	− 1.07
BSIZE	7.28	7.00	0.28	0.95
INVESTEES	3.21	3.18	0.03	− 0.77
TAXTH	1.84	1.79	0.05	− 1.35
Observations	1348	1348		

governance characteristics. Thus, any resulting differences between the two samples should reflect the pyramiding choice and not pre-existing firm and governance characteristics.

Panel A of Table 2 presents the descriptive statistics for the sample firms used in the tests. The mean (median) of abnormal stock returns over 1 year (*ABNORMAL_RET*) is − 6.2% (− 11.4%) and the standard deviation of abnormal returns is more than 40%, suggesting that the returns of our sample firms tend not to perform well and are quite volatile; the mean (median) of a firm's prior-year cash holdings is 18.0% (13.3%) of its market value of equity. The mean (median) of the change in cash holdings (*ΔCASH*) is 2.40% (0.05%) of the market value of equity; the mean (median) of the change in net income (*ΔEARN*) is 1.30% (− 0.06%) of the market value of equity; the mean (median) of the change in net assets (*ΔNetAssets*, measured as total assets minus cash holdings) is 5.8% (4.6%) of the market value of equity; the changes in R&D investment, interest payments, and dividend payouts each year, on average, are small (means are 0.2% for R&D investment; − 0.1% for interest payments, and 0.5% for dividend payouts). On average, firms receive cash proceeds of 0.6% over the prior-year market value of the equity from net issuance of equity and liability. The average (median) market leverage ratio (*MLEV*) is 26.9% (20.3%). Panel B of Table 2 presents the Pearson and Spearman correlations for the variables used in our tests.

5.3 Results for the value of cash holdings

Table 3 presents the results of Eq. (2).[6,7] In column (1), we first replicate the results in Faulkender and Wang (2006). Consistent with Faulkender and Wang (2006), the results show that an extra dollar of cash is valued by shareholders at only $0.93. The coefficients for the changes in earnings (*ΔEARN*), change in net assets (*ΔNetAssets*), change in R&D (*ΔRD*), and change in dividend payout (*ΔDIVIDEND*) are significantly positive and qualitatively the same as those reported in Faulkender and Wang (2006). These results suggest that markets consider increases in earnings, net assets, R&D expenditures, and dividends as value added to the shareholders. The coefficient on $CASH_{i,t-1} \times \Delta CASH$ is insignificant, suggesting that, unlike U.S. firms, the marginal value of cash holdings for Taiwan firms is not significantly sensitive to the amount of cash the firm already has on hand. The coefficient on $MLEV \times \Delta CASH$ is − 4.38, significant at the 0.1% level, suggesting that the marginal value of cash for Taiwanese firms is significantly sensitive to the percentage of the firm's capital structure that consists of debt. This result is consistent with the findings in Faulkender and Wang (2006) and suggests that the marginal value of cash decreases as a firm's leverage ratio increases. According to Faulkender and Wang (2006), when a firm is highly leveraged, more of the firm value generated by holding additional cash benefits debt holders while less of the value associated with an increase in cash accrues to the stock holders. Put differently, the value of cash holdings to shareholders is lower when the firm has more debt.

[6] Following some other studies, such as Pinkowitz et al. (2006), we also use Fama and French's (1998) valuation regression as a robustness check, where the market value of the firm is regressed on cash holdings, the variables of interest, and a set of control variables. The inferences from the untabulated results do not change.

[7] Instead of using cash and cash equivalents to measure a firm's cash holdings, we also include marketable securities as cash holdings, as do Faulkender and Wang (2006), because marketable securities can also be converted to cash easily; the results are qualitatively the same.

Table 2 Descriptive statistics

Variable	Mean	SD	Q1	Median	Q3
Panel A: Descriptive statistics for full sample (N = 2696)					
ABNORMAL_RET	− 0.062	0.406	− 0.295	− 0.114	0.090
ΔCASH	0.024	0.103	− 0.014	0.005	0.060
ΔEARN	0.013	0.124	− 0.014	− 0.006	0.042
ΔNetAssets	0.058	0.345	− 0.023	0.046	0.094
ΔRD	0.002	0.013	0.000	0.002	0.005
ΔINTEREST	− 0.001	0.011	− 0.001	0.000	0.000
ΔDIVIDEND	0.005	0.023	0.000	0.000	0.009
NF	0.006	0.094	− 0.019	0.000	0.005
$CASH_{i,t-1}$	0.180	0.168	0.080	0.133	0.209
$CASH_{i,t-1} \times \Delta CASH$	0.008	0.161	− 0.001	0.000	0.004
MLEV	0.269	0.227	0.065	0.203	0.446

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Panel B: Correlation (N = 2696)											
1. ABNORMAL_RET	1.000	0.287	0.279	0.082	0.136	0.051	0.250	0.152	0.104	0.289	0.157
		(0.000)	(0.000)	(0.000)	(0.000)	(0.009)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
2. ΔCASH	0.264	1.000	0.193	− 0.049	0.125	0.047	0.174	0.075	− 0.038	0.971	0.161
	(0.000)		(0.000)	(0.012)	(0.000)	(0.016)	(0.000)	(0.000)	(0.048)	(0.000)	(0.000)
3. ΔEARN	0.343	0.228	1.000	0.317	0.204	− 0.061	0.582	0.149	0.065	0.197	0.041
	(0.000)	(0.000)		(0.000)	(0.000)	(0.002)	(0.000)	(0.000)	(0.001)	(0.000)	(0.034)
4. ΔNetAssets	0.229	0.188	0.121	1.000	0.154	0.305	0.342	0.320	0.153	− 0.026	0.162
	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.177)	(0.000)
5. ΔRD	0.094	0.094	− 0.041	0.158	1.000	0.153	0.180	0.148	− 0.075	0.126	− 0.173
	(0.000)	(0.000)	(0.032)	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Table 2 continued

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
6. ΔINTEREST	− 0.085	0.059	− 0.200	0.422	0.078	1.000	− 0.095	0.214	− 0.146	0.036	0.054
	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)	(0.064)	(0.005)
7. ΔDIVIDEND	0.397	0.230	0.472	0.167	− 0.002	− 0.132	1.000	0.185	0.190	0.189	− 0.066
	(0.000)	(0.000)	(0.000)	(0.000)	(0.921)	(0.000)		(0.000)	(0.000)	(0.000)	(0.001)
8. NF	0.148	0.281	0.061	0.165	0.053	0.004	0.062	1.000	− 0.043	0.065	0.147
	(0.000)	(0.000)	(0.002)	(0.000)	(0.006)	(0.846)	(0.001)		(0.027)	(0.001)	(0.000)
9. $CASH_{i,t-1}$	0.244	0.045	0.175	− 0.075	− 0.063	− 0.356	0.172	0.065	1.000	0.064	0.532
	(0.000)	(0.019)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)		(0.001)	(0.000)
10. $CASH_{i,t-1} \times \Delta CASH$	0.096	0.525	− 0.010	0.188	0.012	0.200	0.056	0.061	0.054	1.000	0.203
	(0.000)	(0.000)	(0.609)	(0.000)	(0.538)	(0.000)	(0.004)	(0.002)	(0.005)		(0.000)
11. MLEV	0.106	0.109	0.006	0.055	− 0.081	− 0.069	− 0.065	0.083	0.476	0.052	1.000
	(0.000)	(0.000)	(0.775)	(0.005)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.007)	

The denominator $M_{i,\ t-1}$ is skipped for abbreviation

Table 3 The value of cash holdings and investment layers

	(1)	(2)	(3)VIF
Intercept	− 0.199	− 0.217	
	(− 7.00)***	(− 7.44)***	
ΔCASH	0.930	2.686	2.90
	(5.09)***	(14.44)***	
DLARGE		0.075	1.06
		(2.82)**	
DLARGE × *ΔCASH*		− 2.014	2.08
		(− 8.15)***	
ΔEARN	0.464	0.492	1.25
	(2.91)**	(3.12)**	
ΔNetAssets	0.196	0.200	1.32
	(3.86)***	(3.97)***	
ΔRD	2.470	2.426	1.89
	(3.02)**	(2.96)**	
ΔINTEREST	− 1.655	− 1.711	1.32
	(− 1.16)	(− 1.20)	
ΔDIVIDEND	3.691	3.493	1.19
	(5.94)***	(5.68)***	
NF	0.188	0.229	1.15
	(0.91)	(1.12)	
$CASH_{i,t-1}$	0.449	0.450	1.13
	(4.86)***	(4.91)***	
$CASH_{i,t-1}$ × *ΔCASH*	0.136	0.127	1.10
	(1.25)	(1.18)	
MLEV	− 0.067	− 0.168	1.06
	(− 1.49)	(− 2.75)**	
MLEV × *Δ_CASH*	− 0.882	− 0.627	4.13
	(− 4.38)***	(− 3.02)**	
Control for industry and year	Yes	Yes	
N	2696	2696	
Adj. R^2	0.288	0.307	

t statistics in parentheses
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

We report the results of Eq. (2) in column (2) of Table 3. The coefficient on *DLARGE* is positive, which indicates that abnormal return on average is higher for firms with a long chain of layers than firms with a short chain of layers. One possible reason is that, as shown in Table 1 Panel B, firms with a long chain of layers have high growth opportunity (*MB*) than firms with a short chain of layers. As for our main variable of interest, the coefficient on *DLARGE* × *ΔCASH* is − 2.014, negative and significant at the 0.1% level. In line with our H1, the results suggest that the value of holding an extra dollar of cash decreases with the number of investment layers. Thus, the findings support the argument that a large number of investment layers is associated with higher agency costs for cash holdings (less efficient use of cash holdings).

To check for severe multicollinearity problems in the OLS regression, we report the variance inflation factor (VIF) for each independent variable in column (3). The rule of

thumb is that there is evidence of multicollinearity problems if the variance inflation factor (VIF) is larger than 10 (Gujarati 1995). None of the VIFs are greater than 5, suggesting that the variance of the estimated regression coefficients are not inflated due to multicollinearity.

5.4 Results for the value of cash holdings with regard to the deviation between cash flow rights and voting rights

H2 suggests that as the deviation between cash flow rights and voting rights increases, the controlling shareholders have more incentives and ability to divert firm value through misuse of cash holdings. In column (1) of Table 4, the coefficient on $DLARGE \times DEV \times \Delta CASH$ is − 11.985, negative and significant at the 0.1% level, suggesting that on average, high deviation between cash flow and voting rights along with more investment layers is associated with higher agency costs for cash holdings, leading to the lower marginal value of an extra dollar of cash that accrues to shareholders.

Column (2) of Table 4 presents the results for the subsample of firms for which the ownership of any successive layer of subsidiaries is below 50% (i.e., high deviation). The coefficient on $DLARGE \times \Delta CASH$ is − 2.772, significantly negative at the 0.1% level. The findings suggest that high deviation between cash flow and voting rights accelerates the agency costs of cash holdings that the large number of investment layers has already introduced. In contrast, in column (3), the coefficient on $DLARGE \times \Delta CASH$ is 1.039, significantly positive at the 1% level for the subsample of firms for which the ownership of any successive layers of subsidiaries is above 50% (i.e., low deviation). These findings indicate that without the agency costs from the large deviation between cash flow and voting rights, the value of cash holdings increases with the number of investment layers, supporting the notion that firms with many investment layers maintain higher cash balances to facilitate empire-building investments.

5.5 Results for the value of cash holdings with regard to the presence of family control

H3 suggests that when a family controls a firm, the family controlling shareholders have more incentives and ability to divert firm value and misuse cash reserves. Consistent with this argument, we predict that the association between the value of cash holdings and the number of investment layers varies systematically with the presence of family control. In column (1) of Table 5, the coefficient on $DLARGE \times FF \times \Delta CASH$ is − 7.36, negative and significant at the 0.1% level, suggesting that on average, the presence of family control along with a large number of investment layers is associated with higher agency costs of cash holdings, leading to a lower marginal value of an extra dollar of cash accruing to shareholders.

Column (2) of Table 5 presents the results for the subsample of family-controlled firms. The coefficient on $DLARGE \times \Delta CASH$ for family firms is − 4.384, significantly negative at the 0.1% level. The findings suggest that the presence of family control increases the agency costs of cash holdings. In contrast, in column (3), the coefficient on $DLARGE \times \Delta CASH$ for non-family firms is 3.062, significantly positive at the 1% level. The results suggest that without family control, the agency costs of cash holdings associated with a large number of investment layers is reduced.

Table 4 The value of cash holdings and investment layers for high/low deviations

	(1) Full sample	(2) High deviation	(3) Low deviation
Intercept	0.002	− 0.318	− 0.064
	(0.08)	(− 18.18)***	(− 4.11)***
ΔCASH	3.900	0.272	− 0.175
	(4.03)***	(8.26)***	(− 6.43)***
DLARGE	− 0.185	3.981	− 0.423
	(− 4.19)***	(6.42)***	(− 1.15)
DLARGE × *ΔCASH*	4.361	− 2.772	1.039
	(4.39)***	(− 4.17)***	(2.68)**
DEV	− 0.396		
	(− 6.71)***		
DEV × *ΔCASH*	12.371		
	(6.52)***		
DLARGE × *DEV*	0.527		
	(6.87)***		
DLARGE × *DEV* × *ΔCASH*	− 11.985		
	(− 6.12)***		
ΔEARN	0.484	0.368	0.752
	(3.03)**	(3.96)***	(9.17)***
ΔNetAssets	0.220	0.274	0.207
	(4.44)***	(6.89)***	(7.78)***
ΔRD	2.343	3.464	− 0.105
	(2.65)**	(4.41)***	(− 0.15)
ΔINTEREST	− 2.058	− 0.999	− 4.100
	(− 1.43)	(− 0.94)	(− 4.16)***
ΔDIVIDEND	3.635	2.175	3.491
	(6.05)***	(4.02)***	(8.25)***
NF	0.205	0.224	0.073
	(1.00)	(1.71)	(0.84)
$CASH_{i,t-1}$	0.398	0.353	0.455
	(4.56)***	(4.46)***	(7.44)***
$CASH_{i,t-1}$ × *ΔCASH*	0.114	0.050	0.295
	(1.00)	(0.30)	(4.48)***
MLEV	− 0.022	− 0.160	0.077
	(− 0.37)	(− 2.08)*	(1.31)
MLEV × *ΔCASH*	− 0.599	− 1.292	− 0.791
	(− 2.96)**	(− 2.61)**	(− 4.57)***
Control for industry and year	Yes	Yes	Yes
N	2696	1348	1348
Adj. R^2	0.305	0.326	0.356

t statistics in parentheses $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Table 5 The value of cash holdings and investment layers for family firms

	(1) Full sample	(2) Family firm	(3) Non-family firm
Intercept	− 0.226	− 0.228	− 0.155
	(− 20.97)***	(− 19.53)***	(− 4.61)***
ΔCASH	4.839	0.047	− 0.003
	(28.80)***	(1.50)	(− 0.08)
DLARGE	4.061	5.022	− 2.462
	(2.97)**	(15.62)***	(− 3.59)***
DLARGE × *ΔCASH*	− 4.368	− 4.384	3.062
	(− 13.22)***	(− 12.24)***	(4.42)***
FF	0.081		
	(3.75)***		
FF × *ΔCASH*	− 7.208		
	(− 19.40)***		
DLARGE × *FF*	− 0.070		
	(− 2.25)*		
DLARGE × *FF* × *ΔCASH*	− 7.360		
	(− 16.14)***		
ΔEARN	0.489	0.391	0.510
	(3.20)**	(3.18)**	(6.34)***
ΔNetAssets	0.225	0.212	0.223
	(4.55)***	(5.37)***	(7.03)***
ΔRD	2.613	0.761	3.969
	(3.14)**	(1.14)	(4.63)***
ΔINTEREST	− 1.635	− 4.666	− 1.166
	(− 1.14)	(− 3.18)**	(− 1.21)
ΔDIVIDEND	3.817	2.288	4.321
	(6.10)***	(4.08)***	(9.34)***
NF	0.207	0.598	0.170
	(1.02)	(3.53)***	(1.82)
$CASH_{i,t-1}$	0.467	0.579	0.435
	(5.29)***	(7.68)***	(6.17)***
$CASH_{i,t-1}$ × *ΔCASH*	0.103	− 0.007	0.124
	(0.93)	(− 0.06)	(1.46)
MLEV	− 0.058	− 0.082	− 0.036
	(− 0.90)	(− 1.04)	(− 0.51)
MLEV × *ΔCASH*	− 0.525	− 0.451	− 0.570
	(− 2.41)*	(− 2.00)*	(− 2.06)*
Control for industry and year	Yes	Yes	Yes
N	2696	1205	1491
Adj. R^2	0.314	0.327	0.279

t statistics in parentheses $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

6 Additional analyses

6.1 Corporate governance

Prior literature has documented the association between corporate governance, valuation, and cash holdings. For example, Harford et al. (2008) find that low shareholder rights and excess cash adversely affect firm valuation, as the interaction between free cash and poor governance practices may lead to value-reducing activities such as paying an excessive amount for an acquisition target. Likewise, Dittmar and Mahrt-Smith (2007) find that firms with poor corporate governance tend to dissipate cash far more quickly, and in ways that will significantly reduce their operating performance; however, good governance moderates this negative impact of large cash holdings on future operating performance. Thus, we further control for the governance features of a firm and see whether our results still hold.

Following prior literature (e.g., Gul et al. 2017; Hsu and Liao 2013), we construct a summary index consisting of six governance variables to measure the strength of the firm's corporate governance. We adopt six indicators that capture the multi-dimensions of governance strength and are representative of the governance scheme in Taiwan: (a) whether the CEO and the chairman of the board are the same individual, (b) board size, (c) the proportion of independent directors, (d) the percentage of shareholdings by financial institutions, (e) the percentage of shareholdings by foreign institutions, and (f) the percentage of equity shares used by the directors as a pledge for financing.

Specifically, to create a composite index that captures a firm's overall governance quality, we create dichotomous measures of each of the six governance characteristics for each firm, such that values of 1 indicate strong governance and values of 0 indicate weak governance. First, because CEOs who are not chairman of the board can provide more effective monitoring (e.g., Beasley 1996), we create *DUALITYD* as 1 if the CEO and the chairman of the board are not the same individual and 0 otherwise. Second, larger boards have been shown to be more effective than smaller boards because they have a greater knowledge base for fulfilling their advisory role (Coles et al. 2008) and a greater ability to distribute the workload to perform their monitoring duties than do smaller boards (Anderson et al. 2004); thus we code *BSIZED* as 1 for firms with board size more than the sample median and 0 otherwise. Similarly, more board independence (*INDED)* has been shown to indicate stronger corporate governance (e.g., Beasley 1996). We code *INDED* as 1 for firms for which the proportion of independent directors on the board is greater than the sample median and 0 otherwise. In addition, institutional investors, by nature of their large stockholdings, have incentives to monitor corporate performance, indicating strong governance (Shleifer and Vishny 1986; Jarrell and Poulsen 1987). Therefore, we code *INSTD* as 1 for firms for which the proportion of institutional ownership is greater than the sample median and 0 otherwise. We code foreign institutional investors, *FOREIGN_INSTD,* as 1 for firms for which the proportion of foreign institutions is greater than the sample median and 0 otherwise. In addition, if the directors use the shares as a pledge for financing, they may face high finance risks and not have incentives to act in shareholders' benefits. Thus *PLEDGED* is coded as 1 for firms whose percentage of equity shares used by the directors as a pledge for financing is smaller than the sample median and 0 otherwise. The six dichotomized variables are then added to obtain a composite index

(*GOV*), ranging from 0 to 6, that captures the strength of the firm's overall governance environment.[8] We then alter the basic model by incorporating *GOV* in Eq. (5):

$$\begin{aligned} ABNORMAL\_RET_{it} = {} & \beta_0 + \beta_1 \frac{\Delta CASH_{it}}{M_{it-1}} + \beta_2 DLARGE_{it} + \beta_3 DLARGE_{it} \times \frac{\Delta CASH_{it}}{M_{it-1}} + \beta_4 GOV_{it} \\ & + \beta_5 GOV_{it} \times \frac{\Delta CASH_{it}}{M_{it-1}} + \beta_6 \frac{\Delta EARN_{it}}{M_{it-1}} + \beta_7 \frac{\Delta NetAssets_{it}}{M_{it-1}} + \beta_8 \frac{\Delta RD_{it}}{M_{it-1}} \\ & + \beta_9 \frac{\Delta INTEST_{it}}{M_{it-1}} + \beta_{10} \frac{\Delta DIVIDEND_{it}}{M_{it-1}} + \beta_{11} \frac{NF_{it}}{M_{it-1}} + \beta_{12} \frac{CASH_{it-1}}{M_{it-1}} \\ & + \beta_{13} \frac{CASH_{it-1}}{M_{it-1}} \times \frac{\Delta CASH_{it}}{M_{it-1}} + \beta_{14} MLEV_{it} + \beta_{15} MLEV_{it} \times \frac{\Delta CASH_{it}}{M_{it-1}} \\ & + INDSTRYdummy + YEARdummy + \varepsilon_{it} \end{aligned} \tag{5}$$

The results are presented in Table 6. After we control for corporate governance mechanisms, the coefficient on the interaction between *DLARGE* and *ΔCASH* is − 4.043, still significantly negative at the 0.1% level. The results are qualitatively the same as reported in Table 3.

6.2 Alternative measure of unexpected change in cash holdings

Following Faulkender and Wang (2006), we also use the realized change in cash holdings minus the average change in cash holdings in the corresponding benchmark portfolio over the same period (*Portfolio_Adjusted_ΔCASH*) to measure the unexpected change in cash holdings. As there is a time trend (Bates et al. 2009) and industry-specific variation in the level of cash holdings, we reduce the impact of the time trend and industry variation by benchmarking a given firm's change in cash holdings relative to that of similar-sized, similar book-to-market firms in the same industry. If on average, firms in the same size and book-to-market portfolio increase their cash holdings during the fiscal year, the average returns of the benchmark portfolio should reflect the effect of the average increase in cash holdings of the portfolio, and excess returns should reflect the response to the change in the firm's cash holding not already reflected in the benchmark returns. The results are presented in Table 7. The coefficient on *DLARGE* × *Portfolio_Adjusted_ΔCASH* is − 0.047, significantly negative, indicating that the results are qualitatively the same as those reported in Table 3.

[8] For U.S. studies, the G-index of Gompers et al. (2003) is usually used to proxy for governance; it is constructed using the U.S. database, Investor Responsibility Research Center (IRRC). IRRC tracks 28 distinct corporate governance provisions, including four provisions that intend to delay hostile takeover bidders, six provisions that protect directors and officers from legal liability and job termination, six provisions that deal with shareholder voting rights, six provisions that address state takeover laws, and six provisions that are related to other takeover defenses. For every firm, Gompers et al. (2003) add one point for every provision that reduces shareholder rights and construct a "Governance Index" as a proxy for the balance of power between shareholders and managers. However, in Taiwan, merger and acquisition is not so common and shareholder activism does not rise as much as in the U.S. Following Gul et al. (2017), we construct an index that adds one point for each governance feature that protects shareholder rights as a proxy for the strength of corporate governance. We believe this index better fits the Taiwan business environment.

Table 6 The value of cash holdings and investment layers; a measure for corporate governance is incorporated

	Full sample
Intercept	− 0.024
	(− 0.36)
ΔCASH	0.876
	(3.80)***
DLARGE	2.014
	(2.98)**
DLARGE × *ΔCASH*	− 4.043
	(− 5.25)***
GOV	− 0.015
	(− 3.21)**
GOV × *ΔCASH*	− 0.010
	(− 0.15)
ΔEARN	0.473
	(6.96)***
ΔNetAssets	0.187
	(6.69)***
ΔRD	1.835
	(4.53)***
ΔINTEREST	− 3.023
	(− 4.69)***
ΔDIVIDEND	3.359
	(9.96)***
NF	0.073
	(0.71)
$CASH_{i,t-1}$	0.614
	(11.50)***
$CASH_{i,t-1}$ × *ΔCASH*	0.002
	(0.08)
MLEV	− 0.144
	(− 4.55)***
MLEV × *Δ_CASH*	− 0.506
	(− 2.68)**
Control for industry and year	Yes
N	2696
Adj. R^2	0.336

t statistics in parentheses
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

6.3 Cross-sectional variation

In this study, we argue that the negative association between the number of investment layers and the value of cash holdings is consistent with the view that firms with more investment layers maintain higher cash balances to facilitate empire-building over investment. In this section, we further identify the underlying mechanism behind our main findings by conducting two cross-sectional analyses.

Table 7 Alternative measure for change in corporate cash holdings

	Full sample
Intercept	− 0.104
	(− 5.83)***
Portfolio_Adjusted_ΔCASH	0.684
	(2.33)*
DLARGE	0.073
	(0.35)
DLARGE × *Portfolio_Adjusted_ΔCASH*	− 0.047
	(− 3.71)***
ΔEARN	0.486
	(7.01)***
ΔNetAssets	0.186
	(6.44)***
ΔRD	1.878
	(4.43)***
ΔINTEREST	− 3.257
	(− 4.93)***
ΔDIVIDEND	3.789
	(11.20)***
NF	0.075
	(0.70)
$CASH_{i,t-1}$	0.567
	(10.77)***
$CASH_{i,t-1}$ × *Portfolio_Adjusted_ΔCASH*	− 0.065
	(− 5.01)***
MLEV	− 0.050
	(− 1.65)
MLEV × *Δ_CASH*	− 0.625
	(− 2.74)**
Control for industry and year	
N	2696
Adj. R^2	0.325

t statistics in parentheses
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

6.3.1 Corporate governance

First, we test whether our main findings are more pronounced in firms with high agency problems. Dittmar et al. (2003) argue that cash hoarding by firms is value reducing when agency problems are high. Following Dittmar et al. (2003), we use the strength of corporate governance to capture the size of agency costs. We expect the negative association to be more pronounced for poorly governed firms than for well-governed firms. Based on the composite scores for corporate governance constructed as described in Sect. 6.1, we define a firm as poorly-governed firm if its composite score is less than 3, and the rest as firms with strong governance. We separately estimate our model for firms with strong and weak governance. Table 8 Panel A reports the results. To conserve space, we report only the coefficients on cash holdings and the interaction between layers and cash holdings. The

Table 8 The value of cash holdings and investment layers: cross-sectional analyses

	(1) Weak governance	(2) Strong governance
Panel A: corporate governance		
ΔCASH	− 0.054	0.023
	(− 0.89)	(1.54)
DLARGE	− 0.702	− 2.689
	(− 1.90)*	(− 2.15)**
DLARGE × *ΔCASH*	− 2.341	0.009
	(− 4.42)***	(1.24)
N	1234	1462
Adj. R^2	0.289	0.246
	(1) Low credit rating	(2) High credit rating
Panel B: financial constraints based on credit ratings		
ΔCASH	0.074	0.178
	(1.12)	(1.89)*
DLARGE	− 2.145	− 1.562
	(− 1.79)*	(− 0.98)
DLARGE × *ΔCASH*	− 1.502	− 1.745
	(− 2.07)*	(− 2.89)**
N	1150	1546
Adj. R^2	0.156	0.325

t statistics in parentheses
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

results indicate that the negative relation between layers and cash holdings (*DLARGE* × *ΔCASH*) is significantly stronger for firms with weak corporate governance than for firms with strong corporate governance. The findings in Table 8 Panel A are in line with the notion that a large number of investment layers increases managerial discretion for suboptimal investment decisions.

6.3.2 Financial constraints

We also examine whether our results are mainly driven by firms with no financial constraints. We separately report our results for financially constrained and unconstrained firms. Following Denis and Sibilkov (2010), we employ credit ratings as a proxy for financial constraint, using the Taiwan Corporate Credit Risk Rating to measure the credit rating. The Taiwan Corporate Credit Risk Index (TCRI) is a corporate credit rating system developed by TEJ. Credit ratings from TEJ are from 1 to 10, with "1" indicating the best credit rating and "10" the worst. We define firms with a rating between 6 and10 as financially constrained firms and a rating between 1and 5 as unconstrained. Table 8 Panel B reports the results. For brevity, we report only the results for the cash holdings variable and the interaction between the cash holdings and number of layers. The results show that the coefficient on the interaction term between cash flow and layers is negative and significant for both constrained and unconstrained firms. The results suggest that our main findings are not driven by financially unconstrained firms.

7 Conclusion

We examine whether the value of a firm's cash holdings is influenced by its organizational structure (i.e., the number of layers within the corporate pyramid), ownership structure (i.e., the deviation between cash flow and voting rights), and the presence of family control. To address these research questions, we employ a sample of publicly traded companies in Taiwan, since all publicly traded companies in Taiwan are required to disclose information on all of their subsidiaries according to CGPAR, which allows us to calculate the number of layers based on publicly available affiliation information. We find that firms with more layers are associated with a lower value of cash holdings. The results support the agency theory of cash holdings, suggesting that although pyramidal firms enjoy the benefits of internal capital markets, as indicated by prior studies (Khanna and Yafeh 2005; Gopalan et al. 2007; Masulis et al. 2011), as agency costs increase with the number of investment layers, the value to shareholders of holding additional cash decreases. In addition, we find that the negative association is stronger when the parent firm's ownership of the lower-layered subsidiaries is less than its voting rights (i.e., the deviation between cash flow and voting rights is high) and when firms are controlled by family owners. These results further support the agency theory of cash holdings since firms whose ownership structure creates a wide deviation between cash flow and voting rights and firms which are controlled by family owners are characterized as having more agency conflict between controlling and non-controlling shareholders.

Appendix

Variable definitions

(1) Variables of interests	
LAYER	The number of investment layers of the longest investment chain in a firm's investment structure
DLARGE	An indicator which equals 1 if the number of layers is equal to or greater than 3 and 0 otherwise
DEV	An indicator variable which equals one if the parent firm has any subsidiary within the investment structure with ownership of less than 50% and zero otherwise
FF	An indicator variable which equals one when the family members either hold the position of CEO or chairman of the board of directors, have more than 50% of the directorship, or hold more control rights than what it is necessary to maintain control over the company, and zero otherwise
LEGAL	The legal environment score given by La Porta et al. (2000) for the country where the subsidiary is located
(2) Variables used for propensity score matching procedure	
SIZE	The natural logarithm of total net assets in year *t*, where net assets is total assets minus cash assets
MB	The ratio of the book value of debt plus the market value of equity scaled by total assets
BLEV	The ratio of total debts to total assets, where total debts consist of short-term debts and long-term debts
CAPEX	The ratio of the capital expenditure for firm *i* at time *t* (cash outflows or the funds used for additions to the company's property, plant and equipment, excluding amounts arising from acquisitions, reported in the Statement of Cash Flows) to net assets

INVESTEE	The natural logarithm of the number of investees
TAXH	The natural logarithm of the number of investees in tax havens, based on the list of tax havens in Dyreng and Lindsey (2009)
DUALITY	An indicator variable that equals one if the CEO also serves as chairman of the board and zero otherwise
INSIDEB	Director ownership
INSIDEM	Management ownership
INST	The percentage of common stocks held by institutional investors
FOREIGN_INST	The percentage of common stocks held by foreign institutional investors
INDE	The proportion of independent directors
PLEDGE	The percentage of equity shares used by blockholders as a pledge for financing
BSIZE	The natural logarithm of the number of directors sitting on the board
(3) Variables used in the cash valuation model of Faulkender and Wang (2006)	
ABNORMAL_RET	Abnormal stock returns, measured as the stock returns for firm i over fiscal year t minus the annual returns of a benchmark portfolio based on Fama and French's 25 size-book-to-market portfolio classifications for each year
$M_{i,\ t-1}$	The market value of firm i at time $t-1$
CASH	Cash holdings of firm i at time t
EARN	Earnings before interest and taxes of firm i at time t
NetAssets	The net assets of firm i at time t, calculated by total assets minus cash
RD	Research and development expenditures of firm i at time t, set to zero if it is missing
INTEREST	Interest expense of firm i at time t
DIVIDEND	The total amount of dividends (other than stock dividends) declared on the common stocks of firm i at time t
NF	Net financing, the funds received from equity issuance minus repurchases plus funds received from debt issuance minus debt redemption, i.e., sale of common and preferred stock (on statement of cash flows) + sale of common stock to employees (on statement of cash flows) − stock repurchase (on statement of cash flows) + long-term debt issuance (on statement of cash flows) − long-term debt reduction (on the statement of cash flows)
$CASH_{\ i,\ t-1}$	Cash holdings of firm i at time $t-1$
MLEV	Market leverage for firm i at time t, calculated as total debt divided by total debt plus market value of equity
(4) Other variables	
DUALITYD	An indicator which equals 1 if the CEO and the chairman of the board are not the same individual and 0 otherwise
BSIZED	An indicator which equals 1 for firms with board size more than the sample median and 0 otherwise
INDED	An indicator which equals 1 for firms for which the proportion of independent directors on the board is greater than the sample median and 0 otherwise
INSTD	An indicator which equals 1 for firms for which the proportion of institutional ownership is greater than the sample median and 0 otherwise
FOREIGN_INSTD	An indicator which equals 1 for firms in which the proportion of foreign institutions is greater than the sample median and 0 otherwise
PLEDGED	An indicator which equals 1 for firms whose percentage of equity shares used by the directors as a pledge for financing is smaller than the sample median and 0 otherwise

GOV	The six dichotomized variables added, ranging from 0 to 6, that capture the strength of the firm's overall governance environment
Portfolio_Adjusted_ΔCASH	The realized change in cash holdings minus the average change in cash holdings in the corresponding benchmark portfolio over the same period to measure the unexpected change in cash holdings

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