External Monitoring, Managerial Entrenchment, and Corporate Cash Holdings*

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Abstract

We isolate monitoring and managerial entrenchment, which are two forces that affect shareholders' rights in opposite directions, to test their individual impact on the corporate cash holding decision. We develop a model of delegated cash management where both these forces, as well as their interaction, positively affect the level of cash holdings. We empirically test our predictions using a large sample of US firms and find strong evidence corroborating our hypotheses. Our results suggest that single corporate governance measures may not be able to disentangle the multiple effects of the range of notions they encompass.

EFM classification codes: 150, 110.

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1 Introduction

Managers of corporations are on the top of the decision-making hierarchy. Nevertheless, they are still themselves employees. As such, in order to maintain their position their decisions need to be *trusted* and *tolerated* by their employers, the firm's shareholders. In agency theory jargon, these two job security requirements, trust and tolerance, result from better *monitoring*[1] and higher *managerial entrenchment* respectively. In this paper, we attempt to disentangle these two notions and examine their distinct effects on managerial behaviour with regards to corporate cash holdings. These two notions being in the core of what is understood under corporate governance, it is only natural to start our discussion from some relevant developments in this vast research area.

The effect of governance on corporate valuation is widely researched and debated upon, especially during the last decade. In their influential article, Gompers, Ishii, and Metrick (2003) investigate the effect of governance on equity prices. They do so by constructing a "Governance Index" ($GIndex$) consisting of antitakeover provisions that the board of directors has at its disposal in order to defend itself against a hostile bidder. They find that firms with stronger shareholders' rights, as captured by the $GIndex$, have significantly higher values than those with weaker shareholders' rights. On the other hand, Core, Guay, and Rusticus (2006) provide evidence that these results do not hold for operating performance. On the contrary, Bhagat and Bolton (2008) find a positive relation between better governance and better operating performance, but document an absence of relation between governance and stock performance. Bebchuk, Cohen, and Ferrell (2009) refine the $GIndex$ by pinpointing only 6 out of the initial 24 antitakeover provisions which they believe really do "matter in corporate governance", and find that their "Entrenchment Index" ($EIndex$) is strongly related to stock returns. In short, the ongoing debate about whether corporate governance affects firms' value indicates that this is still a very rich area for further research. Although the value-relevance of governance is only a corollary of our study, we aspire to give some valuable

[1]Better monitoring enhances the transparency of managerial actions, and thus reduces shareholders' distrust of managers.

insights concerning the multitude of forces created by the separation of ownership and control.

The verdict on the effect of governance on the value of cash holdings is by far more unanimous. In a cross-country analysis, Pinkowitz, Stulz, and Williamson (2006) provide evidence that corporate cash holdings have significantly lower value in countries where shareholders' (investors') rights protection is weak. On top of country-level rights, Kalcheva and Lins (2007) control for firm-specific governance indicators to find that the results established in prior literature are further strengthened by firm-specific shareholders' rights. Dittmar and Mahrt-Smith (2007) study the impact of corporate governance mechanisms in US firms, where shareholders' rights are considered among the strongest in the world[2]. They find that the value of one dollar of cash held by a poorly governed firm is on average as low as half the value of one dollar of cash held by a better governed counterpart.

Taking a step back, why has determining the value of cash become so important? Cash holdings of listed US firms have increased sharply over the last 25 years. This liquidity boom has naturally attracted an increasing interest of contemporaneous financial research on the determinants of corporate liquidity. In such a study, Bates, Kahle, and Stulz (2009) point out that the average cash holdings of US firms as a percentage of their total assets has more than doubled during the last quarter of a century, increasing from 10.5% in 1980 to 24% in 2004. They also notice that from 2004 to 2006 US firms have on average enough cash to repay all their financial debt at once. In sum, corporate cash holdings have become over time a significant component of a firm's balance sheet, and thus, its valuation is of increasing importance in ultimately determining firm value.

In turn, an obvious question to raise is why, given the low return of liquid assets, do firms choose to keep so much cash. How does the separation of ownership and control affect corporate liquidity? Is it in part responsible for this cash hoarding? If so, what has changed over the last 25 years? Across the related literature (Opler, Pinkowitz, Stulz, and Williamson, 1999; Bates et al., 2009), various causes for the increase of

[2]The interested reader can find an extensive discussion about the prevailing governance regimes worldwide in Shleifer and Vishny (1997).

liquidity have been examined, such as the increased volatility of the business environment, or the decrease of investment in capital assets. This research stream also focuses on the relation between cash holdings and agency costs which have been mainly proxied by the effectiveness of corporate governance. Interestingly, unlike the afore-mentioned convergence of results on the cash-value relevance of corporate governance, the empirical tests of this relation have ambiguous results. Opler et al. (1999), and later Bates et al. (2009), fail to prove an important relation between agency costs and corporate liquidity. In a cross-country study, Dittmar, Mahrt-Smith, and Servaes (2003) find that better governed firms hold less cash than their weaker governed counterparts. Lastly, Harford, Mansi, and Maxwell (2008) report that the opposite is true for U.S. firms, where poorly governed firms have lower cash holdings. However, Harford et al. (2008) do not provide an explanation of why some governance indicators have a positive while others seem to have a negative relation to cash holdings. This ambiguity of results calls for a more thorough examination of the factors that drive the decision of how much cash a corporation holds, and this is exactly the purpose of this study.

Since Jensen and Meckling's (1976) seminal work, significant research has been done towards the determination of the effect of the separation of ownership and control on various aspects of a firm's operation, and consequently the estimation of agency costs that stakeholders of a corporation incur due to the complex contracting relationships that govern it. Still, many corporate decisions are open to different interpretations. The proportion of liquid assets a firm chooses to hold is apparently one of those. Our aim is to disentangle the effect of two principal components of corporate governance, namely monitoring and entrenchment, and determine how each of those affects the cash holding decision.

We propose a simple model of cash accumulation model in an attempt to capture these two components of the principal-agent conflict in a simple, yet meaningful, way. Our model begins with shareholders delegating the firm's liquidity management to a manager. Extending Jensen's (1986) free cash flow hypothesis, we propose that the manager does not extract perquisites from the firm's cash flow per se, but from the level of *accumulated cash* in the form of corporate cash reserves. The manager's hoarding propensity is mitigated by the fact that shareholders hold a right to dismiss him at any time they please. The manager exercises such a liquidity policy that guarantees his job security —a solution that is in line with Faleye's (2004) observation that there are only so few proxy contests recorded, despite them being such a powerful mechanism of corporate control. We predict that both better monitoring and higher entrenchment, albeit notions that would cancel each other out if a single measure of corporate governance was used, both positively affect corporate cash holdings.

We empirically test our predictions on a large sample of US firms for the period 1990–2008, using two alternative specifications. In the first one, we model managerial entrenchment as the managerial performance, which we proxy by the firm's cash flow in excess of the industry median cash flow. In the second specification, we model managerial entrenchment as the cost of firing the manager, where we make use of the manager-friendly legal framework of the state of Delaware. Regarding monitoring, we deviate from extant literature in an attempt to find a measure that is beyond the manager's narrow influential sphere. We search for external monitoring mechanisms in order to avoid issues of the "who controls the controllers" type, which are more often than not present in internal monitoring devices. Therefore, in both specifications, we proxy monitoring using a measure of analyst coverage of the firm's stock. Consistent with our predictions, we find not only significant evidence that both better monitoring and higher entrenchment are positively related with cash holdings, but also evidence that the interaction between these two explanatory variables further strengthens these positive effects.

The remainder of this paper is structured as follows. Section 2 introduces our theoretical model of delegated cash accumulation and presents our empirical predictions. In Section 3, we present the tests of these predictions against real data of US firms, and discuss the results. Section 4 concludes.

2 Model

In this section, we propose a simple model of cash accumulation capturing the effect of the separation of ownership and control on liquidity management. In the subsections that follow, we expose the model setup, discuss the quantitative results, and conclude by formulating testable empirical implications.

2.1 Setup

Our setup follows a (s,S) inventory policy framework, as exposed in Dixit (1993). We consider a firm, the cumulative operating cash flows (Y_t) of which evolve according to an absolute Brownian Motion, such that

$$dY_t = \mu dt + \sigma dW_t \tag{1}$$

where $\mu > 0$ represents the expected operating cash flows in a time period dt, $\sigma > 0$ the standard deviation of these cash flows, and dW_t the increment of a standard Wiener process.

The firm can solely be refinanced with equity which is issued when the firm is in need of funds. The cost of external funding entails fixed costs, denoted by ϕ. If we let dE_t denote the amount of equity issued by the firm at time t, the total cost of issuance, dF_t, is equal to

$$dF_t = \phi 1_{dE_t > 0} \tag{2}$$

where $1_{dE_t > 0}$ is a indicator taking a value of 1 if the firm decides to issue equity and 0 otherwise. We intentionally do not include marginal costs of external financing, since we believe those to be largely a consequence of the cost of carrying cash, which is explicitly incorporated into our model.

In our setup, the cost of carrying cash captures the effectiveness of a firm's monitoring mechanisms, a major component of what is understood under corporate governance. Shleifer and Vishny (1997) define "corporate governance deals with the ways in which suppliers of finance to corporations assure themselves of getting a return on their investment". Among other things, this definition encompasses the fact that is less costly for shareholders of better governed firms to keep a portion of their wealth in the form of corporate cash. Thus, better monitored firms experience a lower cost-of-carry, which we denote by θ.

We denote the firm's cash holdings at time t by C_t. Cash kept into the firm earns the risk-free interest rate r less the cost-of-carry θ. We also assume a fixed level of debt, d, towards which the firm pays a risk-free coupon, equal to rd[3]. Letting dU_t denote the incremental payout to shareholders, the corporate cash inventory evolves according to

$$dC_t = dY_t + [(r - \theta) C_t - rd] \, dt + dE_t - dU_t \tag{3}$$

which is simply the instantaneous operating cash flow, plus the interest generated by existing cash net of the cost-of-carry, less the interest paid to debtholders, plus the amount of external financing obtained, less the payout to shareholders, in a time interval dt.

The corporate liquidity policy consists of four decisions: a) when should the firm pay out cash to equityholders, b) how much cash should the firm pay out, c) when should the firm ask for external financing, and d) how much external financing should the firm get. The liquidity policy is thus summarized by a two barrier policy, the payout barrier, and the external financing barrier. When the level of cash, C_t, reaches the upper threshold, $\overline{C}$, the firm pays out an amount of cash, equal to ν, to equityholders; and the level of cash jumps from $\overline{C}$ to $(\overline{C} - \nu)$. Similarly, when the level of cash drops to a lower threshold, $\underline{C}$, equity is issued, and an amount of cash, equal to m, flows into the firm, and the level of cash instantaneously jumps from $\underline{C}$ to $(\underline{C} + m)$.

Assuming that there are no direct costs of paying out cash to equityholders, we transform the upper resetting barrier, $\overline{C}$, into a reflecting barrier ($\nu = 0$); such that the firm pays out to equityholders anything above $\overline{C}$, every time this barrier is hit. Also, we set the lower threshold $\underline{C}$ to 0, such that the firm gets external financing whenever it runs out of cash. Thus, the liquidity policy of our firm is in fact reduced

[3] In this study, we examine only cases where it's never optimal for shareholders to default on their debt obligations, and thus, we assume debt to be risk-free.

to two decisions: a) when should the firm pay out cash to shareholders, and b) how much external financing should the firm get when it runs out of cash.

Shareholders can either run the company themselves or appoint an agent to run it on their behalf. The agent-manager is assumed to use his skills to contribute a fixed amount δ to the firm's operating profits, which is now equal to $\mu_1 = (\mu + \delta)$. The manager is paid a fixed wage, equal to a, but is also able to expropriate the cost of carry θ of the firm's cash reserves to his own benefit. Shareholders still keep control of the amount of liquid cash to be injected into the firm when needed, now m_1, but delegate to the manager the payout decision, i.e. the manager sets the new payout threshold, $\overline{C}_1$. Furthermore, shareholders have the right to liquidate the "managed" firm at any point in time for an equivalent of $L(C_t)$. At liquidation, i.e. at time τ^L, the manager loses his position and is assumed to remain unemployed ever after. Thus, shareholders trade off the increased profitability obtained by the manager's skills against a continuous loss proportional to the firm's cash reserves and the delegation of the payout decision to the agent, which is mitigated by the option of shareholders to dismiss the manager whenever they please.

Managers and shareholders affect the firm's cash holdings through the payout and refinancing decisions they respectively make. The manager receives a fixed compensation and is able to extract a portion of cash reserves as private benefits, until shareholders decide to liquidate the firm. Without loss of generality, we normalize a to zero. The managerial objective function is thus

$$\max_{\overline{C}_1} \mathbb{E}\left[\int_0^{\tau^L} (\theta C_t)\, e^{-rt} dt\right]. \tag{4}$$

Shareholders wish to maximize the present value of the total payout they will receive from the firm minus the sum of the equity they will have to inject into the firm and the costs they will incur anytime they choose to do so. The shareholders' objective function can thus be expressed algebraically as

$$\max_{m_1, \tau^L} \mathbb{E}\left[\int_0^{\tau^L} (dU_{1t} - dE_{1t} - dF_{1t})\, e^{-rt} + L(C_{\tau^L}) e^{-r\tau^L}\right]. \tag{5}$$

Lastly, we need to define the liquidation function $L(\cdot)$. In this study, we consider it to be the value of the firm if run by shareholders. Intuitively, at any point in time, shareholders have the right to dismiss the manager and run the company themselves. In this case, the cost of carrying cash becomes zero, but the additional profit δ brought by the manager is lost. In the Appendix, we derive the value of the "principal-run" firm to be equal to

$$L(C_t) = \frac{\mu}{r} + C_t - d - \phi\left(\frac{A(C_t)}{A(0)}\right) \tag{6}$$

where

$$A(C_t) = \frac{\sqrt{r}(\frac{\mu}{r} + C_t - d)}{\sigma} \ \operatorname{erfc}\left(\frac{\sqrt{r}(\frac{\mu}{r} + C_t - d)}{\sigma}\right)\sqrt{\pi}e^{\frac{(\mu - rd)^2}{r\sigma^2}} - e^{-\frac{2r(\frac{\mu}{r} + \frac{C_t}{2} - d)C_t}{\sigma^2}}.$$

and $erfc(\cdot)$ is the complementary error function.

2.2 Numerical results

We solve our model for the upper threshold, $\overline{C}_1$, and the amount of equity issued, m_1, based on different values of our parameters[4]. For the base case, we set the expected operating cash flow, μ, equal to $7,500,000$; the standard deviation of cash flows, σ, to $10,000,000$; the level of debt, d, to $50,000,000$; the fixed refinancing costs, ϕ, to $1,000,000$; the manager's cash tunneling, θ, to 0.02; the managerial contribution to the firm's cash flow, δ, to $1,000,000$, and the risk-free rate of return, r, to 0.05.

After analysing results for the base case, we distinguish four cases based on the firm's monitoring efficiency and managerial entrenchment. Specifically, we let the cost-of-carry take values $\theta \in \{0.01; 0.03\}$, and managerial entrenchment $\delta \in \{750,000; 1,250,000\}$. We label cases that have $\theta = 0.01$ as "Well Monitored", whereas those with $\theta = 0.03$ as "Poorly Monitored"; and those that have $\delta = 750,000$ as "Low Entrenchment", whereas those that have $\delta = 1,250,000$ as "High Entrenchment" firms.

[4]The interested reader can find the solution of the model in the Appendix.

2.2.1 The base case

We first examine the behaviour of the thresholds and average cash holdings for the base case. Figure 1 plots the upper threshold, $\overline{C}_1$ (blue line), the resetting threshold, m_1 (purple line), and the average cash holdings, $\bar{c}$ (yellow line), with respect to different values of the parameters.

As depicted on the top left graph, both $\overline{C}_1$ and m_1 decrease with increases in μ. The decrease of the resetting barrier is due to a *relative* decrease of volatility, and thus a decrease in the probability of incurring the fixed costs of equity issuance. The higher the expected cash flow, the more certain the firm is to generate cash, and thus the lower the need for cash reserves. The decrease of the upper threshold is due to an increase of the shareholders' outside option in value, thus a *relative* decrease of the agent's additional profitability (since δ remains constant) and consequently a decrease of shareholders' *tolerance* towards the manager's perquisite extraction.

The top right graph depicts the results for changes in volatility, *ceteris paribus*. We note that although m_1 consistently increases with volatility, the payout threshold, $\overline{C}_1$, has a non-monotonic relation to this parameter. The increase of the resetting barrier being straightforward, we will focus our attention to the upper threshold. As volatility increases, payout occurs at higher levels of cash because shareholders are more willing to allow the manager to keep more cash into the firm, i.e. the shareholders' outside option decreases quicker in value than the value of the "managed" firm. However, as volatility increases, so does the amount of equity that shareholders are willing to inject into the firm in order to avoid incurring financing costs in the near future; this causes an increase in the cost due to the managerial expropriation of cash, which makes shareholders less tolerant towards this behaviour when the probability of refinancing needs decreases, i.e. at higher levels of cash.

The middle left graph depicts changes in the thresholds due to changes of the level of debt. Since higher debt comes with higher interest payments, higher levels of debt decrease the rate of cash accumulation, dC_t, which in turn causes a decrease of the net cash flow relative to volatility. This decrease in net cash flow causes an increase in the probability of incurring the fixed costs of financing, and thus increases both thresholds

$\overline{C}_1$ and m_1. On the middle right graph, thresholds are plotted against the issuance costs, ϕ. As these costs increase, the amount of equity shareholders are willing to inject in the firm increase, while the payout threshold remains basically unaltered (in fact, there is a small decrease of the upper threshold of -0.02 for each unit increase of ϕ).

The last two graphs capture, from left to right, the changes in the thresholds due to managerial entrenchment and monitoring mechanisms. As the managerial contribution to the firm's profits increases, the manager becomes more "irreplaceable" and the firm gains value relative to the shareholders' outside option. The agent exploits his value-increasing skills by increasing the payout threshold and thus his expropriation of cash to his own benefit. On the right graph, we note that stricter control mechanisms (lower values of θ) also lead to an increase in cash holdings, since the cost of carrying cash decreases. Knowing that the manager is well-monitored, shareholders allow the manager to keep more cash in the firm in order to decrease the probability of them incurring external financing costs in the future.

The graphs also plot the average cash of the ergodic stationary distribution of cash[5] based on the thresholds levels and the net cash flow per increment of time, as exposed in (3). In the top left graph we notice that although $\overline{C}_1$ and m_1 both decrease, long-term average cash holdings increase. This is due to the fact that the average cash flow increases relative to its volatility: as long as the expected cash flow is positive, the less volatile the cash flow is, the closer the average accumulated cash holdings get to the upper threshold. The same explanation is valid for the middle left graph: an increase in debt results in lower expected cash flow, and its relative volatility increases; the more volatile the cash flow is, the more accumulated cash deviates from the upper threshold explaining the depicted simultaneous decrease of average cash holdings and increase of the upper threshold. Similarly, an increase in volatility (top right graph) causes the average cash holdings to decrease, deviating from the upper threshold.

The focus of our paper lies on the last two graphs, the effect of managerial entrenchment and monitoring on corporate cash holdings. Managerial entrenchment in our model affects both the average cash flow and the upper barrier positively; hence,

[5] The derivation of the ergodic distribution, and the calculation of average cash holdings can be found in the Appendix.

the accumulated cash holdings increase. Better monitoring, i.e. lower θ, also affects both the average accumulation rate and the threshold upwards, hence leading to a negative relation between long-term average cash holdings and the lack of monitoring.

2.2.2 Effects of entrenchment and monitoring

Let us now turn to the four cases with different entrenchment and monitoring levels. Figure 2 plots the long-term average cash holdings with respect to the value of four parameters (μ, σ, d, and ϕ) for four cases: $GMHE$ (good monitoring, high entrenchment; blue line), $GMLE$ (good monitoring, low entrenchment; purple line), $BMHE$ (bad monitoring, high entrenchment, yellow line), and $BMLE$ (bad monitoring, low entrenchment, green line).

The top left graph shows that average cash holdings increase with expected cash flow for all four cases. The increase is more pronounced for firms with more entrenched managers. On the top right graph, we plot average cash holdings against cash flow volatility, and observe that the trend is consistently downward for all cases. The bottom left panel depicts the relation of average cash holdings with the level of debt. We note that although the trend is downward for all cases, the effect is more significant for firms with highly entrenched managers. This is due to the fact that firms with entrenched managers have a larger $[0, \overline{C}_1]$ interval, and a decrease of the expected cash flow with respect to its volatility has a larger impact on the higher end of the stationary distribution of cash holdings, hence leading to a larger decrease of the stationary average for $GMHE$ and $GMLE$. Lastly, on the bottom right panel of figure 2, we observe that the effect of financing costs has a minor effect on average cash holdings.

Figure 3 depicts the long-term average cash holdings with respect to our parameters of major interest, δ and θ. On the top panel, we distinguish better monitored (blue line) and poorly monitored (purple line) firms; while on the bottom panel, we distinguish between firms with more entrenched (blue line) and less entrenched (purple line) managers. On top of our main result, i.e. that cash holdings increase with both entrenchment and monitoring separately, we observe that for better monitored firms the positive effect of entrenchment on cash holdings is magnified.

2.3 Empirical predictions

Summarizing our results, we state the main implications of our model in the form of hypotheses.

Hypothesis 1: Corporate cash holdings increase with managerial entrenchment.

Managerial entrenchment makes the firm more valuable compared to shareholders' outside option, i.e. the option to manage the firm themselves. Managers take advantage of their marginal value by keeping more cash into the firm, thus extracting more perquisites from shareholders' wealth over time.

Hypothesis 2: Corporate cash holdings increase with monitoring.

Better monitoring reassures shareholders they will get a return on their investment, and thus increases the value of the firm, ceteris paribus. This reassurance makes it less costly to keep cash into the firm, leading on average to higher cash holdings.

Hypothesis 3: The effect of entrenchment on cash holdings is more pronounced for better monitored firms.

In our empirical tests, we expect, on top of a positive relation between cash holdings and both managerial entrenchment and monitoring, that the relation between cash holdings and a term capturing the interaction between entrenchment and monitoring will also be positive.

For the remaining parameters of our model, we expect average cash holdings to increase with the expected profitability of the shareholders' outside option (μ), to decrease with the volatility of cash flows (σ), to decrease with the level of debt (d), and to remain relatively unaltered by the costs of refinancing (ϕ).

3 Empirical analysis

This section describes the empirical testing of our theoretical results. According to our predictions developed in the previous section, we expect to find a positive relation between cash holdings and two variables capturing monitoring and managerial entrenchment respectively. We first expose the design of our empirical study, then describe the data used, and finally discuss the results.

3.1 Methodology

We follow our theoretical model for the construction of our first empirical specification. Our empirical model contains six parameters that determine corporate cash holdings. These are: operating cash flows (that can be obtained by a principal-run firm), cash flow volatility, leverage, refinancing costs, entrenchment (which in our model is captured by the managerial contribution to the firm's cash flows), and monitoring. While cash flow volatility, leverage, and refinancing costs are relatively straightforward to construct, our main challenge is to find explanatory variables that could separately capture the effect of entrenchment and monitoring. These two notions are often interrelated, and thus not easy to disentangle.

An obvious place to start with is the $GIndex$, proposed by Gompers et al. (2003), or the $EIndex$, as constructed in Bebchuk et al. (2009). These indices consist of 24 and 6 anti-takeover provisions respectively that protect the board of directors and ultimately the management team from hostile takeover attempts. Although these indices may be very useful in capturing effects of governance on the value of the firm, they do not seem appropriate in a study of determinants of cash holdings like ours for two reasons. First, anti-takeover provisions might as well indicate higher managerial entrenchment or lower monitoring from the part of shareholders; according to our model higher entrenchment leads to higher cash holdings, while lower monitoring leads to the opposite effect. Hence, a regression of cash holdings on any of these indices can only lead to inconclusive interpretations. Second, to our knowledge, the determinants of the cross-sectional variation of these indices are still not very clear. Hence, it is probable that the use of these measures could lead to multicollinearity and endogeneity issues: it can be the case that the adoption of some of these provisions is highly correlated with one or more of our remaining explanatory variables; or that both cash holdings and GIndex (or Eindex) are affected by an omitted (or unobservable) variable; or that they are also jointly determined.

To avoid these problems, we try to pinpoint some more exogenous variables that should capture the desired effects. With regards to monitoring, albeit not widely used in cash holdings studies[6], we believe the number of analysts following the stock price of a firm to be a suitable variable for this purpose. Analysts follow closely the firm's fundamentals and make use of their analytical skills and private information to produce estimates about the stock's future performance. Consequently, scrutinizing managerial actions is an undeniable part of their job description. The close examination of the firm by externals increases the transparency of its operations, and makes the expropriation of corporate cash by managers more difficult a task. Accordingly, we hypothesize that the higher the number of analysts following the firm, the more difficult the tunneling of cash becomes for managers. We consider analyst coverage to be exogenous to managerial entrenchment and thus a good candidate for our explanatory variable. Given that the marginal monitoring of an additional analyst is probably decreasing with the number of analysts already following, we use the square root of the number of analysts per year following a firm as our explanatory variable.

Our next concern is to find some exogenous variable that would be able to capture managerial entrenchment. In our first specification, we attempt to closely follow our theoretical model in constructing our independent variables. The challenge is to break up total cash flow, the sum of $(\mu + \delta)$ in our model, into its two distinct components. Recall that μ captures the cash flow that shareholders can get if they run the firm by themselves, while δ corresponds to the incremental firm value added by the manager, which in our model implies entrenchment. Since it could be hard to estimate these variables *ex ante*, we proxy for them using the industry median cash flow and

[6] Analyst coverage is used as a measure of information asymmetry, and consequently lower costs of refinancing, in Kalcheva and Lins(2007) and Denis and Sibilkov (2010).

the difference between the firm's cash flow and the median cash flow of the industry respectively. Intuitively, the industry median cash flow is for shareholders a benchmark of (minimum) acceptable performance; however, the excess cash flow can be considered to be the managerial contribution to the firm's profitability. The higher the excess cash flow, the more *indispensable* the manager is for shareholders. We define cash flow as the ratio of operating income before depreciation minus taxes over net assets (assets minus cash holdings). We use the median cash flow ratio of the industry to proxy for μ, grouping industries by the two-digit SIC codes. Finally, the excess cash flow is simply the difference between the firm's cash flow and the industry median.

In our second specification, we examine managerial entrenchment from a slightly different point of view, namely the one of the cost of firing a manager. Given that we would like our variable to be as exogenous as possible, we employ U.S. corporate legislation concerning hostile takeovers. Previous literature (Bebchuk and Cohen 2005, Low 2009) discusses two crucial court rulings[7] passed in the state of Delaware during 1995 which made hostile takeovers more difficult to succeed, and, consequently, managers' position safer. The safest the manager's position is, the more costly his replacement becomes. In our theoretical model, an increase in the cost of dismissing the manager would pull the shareholders' outside option downwards, hence leaving more freedom to the manager to pay out at higher levels of cash. Since this additional cost does not affect the cash flow rate, (3), an increase in the upper threshold eventually leads to higher average cash holdings[8]. As our second entrenchment variable we use a dummy variable taking the value of one for firms incorporated in Delaware and for years after 1995, and the value of zero otherwise.

The remaining variables of our theoretical model are widely used in the cash holding literature (Harford et al., 2008; Bates et al., 2009). Cash flow volatility is calculated as the standard deviation of the past ten years' cash flow ratio for the industry in which

[7]The first ruling in 'Unitrin v. American General Corp.' allows target firms to hold off hostile riders using a poison pill until the bidder gains control of the board through a proxy contest. The second ruling in 'Moore Corp. Ltd. v. Wallace Computer Services' confirmed the previous ruling by supporting Wallace's right to a poison pill, although Moore had already been tendered 75% of Wallace's shares.

[8]The resetting barrier will also be affected by this cost, but we expect that the effect of its change will be negligible for the ergodic distribution of cash stock.

the firm operates, requiring at least three existing observations during that period; corporate debt is proxied by a leverage ratio of long-term and short-term debt over total assets; and refinancing costs are captured by a firm's size, which we define in our tests as the natural logarithm of assets. We also include some additional control variables that have been suggested as determinants of cash holdings. These are the capital expenditures ratio, defined as capital expenditures over assets; the market to book ratio, calculated as total assets minus book value of equity plus market value of equity over total assets; the R&D ratio, equal to R&D expenses over sales; the acquisition ratio, equal to acquisitions over assets; and a dividend dummy taking the value of one if the firm paid dividend during the fiscal year and zero otherwise. The description of the variables used throughout this study are summarized in Table 1.

To summarize, defining $CashHoldings$ as the ratio of cash and marketable securities over book assets , our first specification can be expressed as

$$\begin{aligned} Cash\ Holdings_{it} = {} & \alpha_0 + \alpha_1 Industry\ Median\ CF_{it} + \alpha_2 Excess\ CF_{it} + \alpha_3 CF\ Volatility_{it} + \\ & + \alpha_4 Leverage_{it} + \alpha_5 Size_{it} + \alpha_6 Analyst\ Coverage_{it} + \\ & + \alpha_7 Excess\ CF_{it} * Analyst\ Coverage_{it} + \epsilon_{it} \end{aligned} \tag{7}$$

where the subscript i denotes a firm in our sample and the subscript t the fiscal year. Our coefficients of main interest are α_2 and α_6, which capture the effects of entrenchment and monitoring respectively. According to our predictions, we expect both these coefficients to be positive and significant. We also expect α_1 to be positive but lower than α_2, reflecting the positive effect of an increase in μ. Opposite to common beliefs and findings of previous literature, we expect α_3 to be negative, reflecting the downward slope of average cash holdings in Figure 1. We discuss this relation in further detail in the result section 3.3. Furthermore, we expect the coefficient α_4 to be negative, and α_5 not to be significant[9]. Lastly, we include an interaction variable to test for *Hypothesis 3*, that the effect of entrenchment is magnified with monitoring. Hence, we expect α_7 to be positive as well.

[9]Since size may also capture some economies of scale, we do not exclude the possibility of α_5 being negative.

Our second specification can be expressed as follows

$$\begin{aligned} CashHoldings_{it} = \alpha_0 + \alpha_1 CF_{it} + \alpha_2 Delaware95_{it} + \alpha_3 CF\ Volatility_{it} + \\ + \alpha_4 Leverage_{it} + \alpha_5 Size_{it} + \alpha_6 Analyst\ Coverage_{it} + \\ + \alpha_7 Delaware95_{it} * Analyst\ Coverage_{it} + \beta Controls_{it} + \epsilon_{it}. \end{aligned} \tag{8}$$

where $Delaware95$ is the dummy variable taking values of one for firms based in Delaware *and* for fiscal years after 1995. In this specification we expect coefficients α_1, α_2, α_6, and α_7 to be positive, and α_3, α_4, and α_5 to be negative. Regarding the control variables, we expect, in accordance with previous literature, that cash holdings are positively related to market-to-book ratio, and R&D expenditures; and negatively related to capital expenditures, net working capital ratio, acquisition ratio, and the dividend payout dummy. Although we recognize that there might be endogeneity issues with these control variables, the main purpose of this study is to add some explanatory variables to extant literature, disentangle the notions of monitoring and entrenchment, without fundamentally altering what has been already achieved.

3.2 Data

We collect financial information data from Standard & Poor's Compustat Fundamentals Annual files, and analyst coverage data from Thomson Reuters' Institutional Broker's Estimate System (I/B/E/S) database. We exclude firm-years that have negative values for assets, sales, cash ratios, leverage ratios, or market-to-book. We also exclude observations with cash ratios higher than one, debt ratios higher than one, or net working capital ratios lower than minus one. To avoid potential outliers, we trim all Compustat variables by 0.5% on each side. We merge the data from both databases and keep the firm-years that have all data items relevant to our analysis. Our final sample consists of $42,506$ firm-years from $6,238$ unique firms for fiscal years between 1990 and 2008.

The descriptive statistics of our sample are provided in Panel A of Table 2. Our dependent variable, cash holdings ratio, has mean value of 0.181, median value of

0.092, and standard deviation of 0.208, reflecting its high variation. The firms in our sample have on average 7.6 analysts following their stock; and almost half of our sample consists of firms based in Delaware for fiscal years after 1995. It is also worth noting that more than half firms-years in our final sample have outperformed their industry median counterparts, although our final sample still includes some very low excess cash flow values, indicating that this variable is highly skewed. Summarizing our sample, the median firm holds 9% of its assets in cash and cash equivalents, has an operating income of 11.7% over its net assets (or 10.6% over its total assets), a cash flow volatility of 20%, a leverage ratio of 17%, a capital expenditure ratio of 4.5%, a market-to-book ratio of 1.56, a net working capital ratio of 9% (18.2% including cash and cash equivalents), a R&D expenditure of 0.4% of its sales, makes no acquisitions, and pays no dividends.

3.3 Results

This section reports the results of our empirical analysis. In Table 3, we present the results of our first specification. Model *I* provides the relations between cash holdings and our explanatory variables for our full sample. In accordance with our expectations, we find that cash holdings ratio increases with analyst coverage, decreases with leverage, and decreases with size. However, our predictions about the effect of entrenchment, industry profitability, and volatility do not hold for this sample. We suspect that these mixed results could be driven by some extreme low values of excess cash flow, as discussed in section 3.2. Our theoretical model is based on the idea that shareholders gain value from the managerial performance, and is meant to hold for profitable firms. Hence, we do not expect our model to hold in cases where either the manager severely underperforms or the firm is consistently making losses, nor in times of market or industry recession. To test the accuracy of our intuition, we decide to reduce our sample to these firm-years where shareholders can expect a profitable near future. To do so, we calculate for each firm year its mean cash flow to net assets ratio of the last five years, with a minimum of three observations. We keep only those firm-years where this mean is higher than or equal to zero, which reduces our sample from $42,506$ to $36,238$ observations. The descriptive statistics of this restricted sample are exposed in Panel B of Table 2.

Model II of Table 3 presents the results of our first specification on the restricted sample. In this model, the results on all variables except cash flow volatility match our predictions. Cash holdings are higher for smaller, better-monitored firms, with higher excess cash flow, lower leverage, which operate in riskier industries. The value of shareholders' outside option (median industry cash flow to net assets) has a positive but mostly insignificant effect on cash holdings, matching the further end of the top left graph in Figure 1. Moreover, the positive coefficient of the interaction term confirms that the effect of entrenchment is enhanced when better monitoring is in place. We repeat the test in Models III to V omitting one variable of interest at a time. In all cases, the coefficients of the variables of interest are the expected ones, with the exception of cash flow volatility. In order to control for potential industry effects that are not captured by our model, we rerun the regression in Model VI using industry fixed effects. The results remain unchanged. Throughout our tests, the results strongly corroborate our theoretical predictions; analyst coverage, excess cash flow, as well as their interaction are all positively related to corporate cash holdings.

In Table 4 provides the results of our second empirical specification. The presentation is similar to the one in Table 3: Model I reports the results of the full sample, while Models II to VI are tested using the restricted sample. To make sure that our results are not driven by omitted variables related to the state of Delaware we include a Delaware incorporation dummy. Similarly, to ensure that a positive coefficient on the $Delaware95$ dummy is not due to the documented increase of cash holdings in the last two decades, we also incorporate a year dummy taking values of one for firm-years after 1995 and zero otherwise. The positive and significant coefficients indicate that cash holdings are strongly and positively related to both analyst coverage and higher costs of dismissing the agent. More specifically, the first analyst following a stock is associated with 0.9% to 2.1% higher cash holding ratios, the second with 0.4% to 0.9% higher, and so on; while Delaware firms hold on average from 0.5% to 1.6% higher cash holdings relative to their total assets after 1995. The interaction coefficient in this specification is insignificant, indicating that an increase of monitoring does not alter the effect of the power of managers to “just say no” to hostile bidders. Besides cash flow volatility, the coefficients on all other explanatory variables have the expected signs and are strongly significant.

We conclude this section with a note on the positive effect that volatility seems to have on cash holdings. In accordance with previous findings, but in contrast with our theoretical model, we find that firms in more volatile industries have on average higher cash holdings, all else equal. Turning back to our model, we suspect this finding to be compatible with a short run distribution of cash. The significant movements of both the upper threshold and the refinancing barrier most likely lead to higher average cash holdings in the short run. Our predictions about lower average cash holdings in the long-run are based on a stationary distribution where the only decision the manager has to make is whether to pay out cash to shareholders or not. In the real world, however, the manager has a variety of decisions to make like how much to invest, or how much to borrow, and many others. One of the features of our model is that the manager gains some utility from keeping as much cash as possible into the firm, and, given the significant increase of the payout threshold, an increase of cash flow volatility is an excellent opportunity for him to do so. If cash holdings are indeed of high value to the manager, he could possibly alter the rest of his decisions in order to hoard more cash. The theory of irreversible investment under uncertainty could complement this idea. A more concrete development and testing of this hypothesis requires a more complete theoretical model as well as a more elaborate empirical design that we leave for future research.

4 Conclusion

We distinguish two separate determinants of shareholders' rights, monitoring and managerial entrenchment, with a view to test their impact on the cash holding decision. We develop a simple model of cash management to predict that both better monitoring and higher managerial entrenchment lead to higher cash holdings. Better monitoring causes a decrease of the manager's expropriation of cash, and consequently a lower cost-of-carry, and enhances shareholders' trust in the manager. Shareholders' reassurance that their returns are safe leads to higher firm cash holdings. Managerial entrenchment makes the agent-run firm more valuable relative to the outside options of shareholders. The manager becomes more indispensable to the firm and shareholders are forced to be more tolerant towards his decisions. The manager takes advantage of this situation by hoarding, and consequently tunneling, more cash to his own benefit. Lastly, we predict that the positive effect of managerial entrenchment on cash holdings is further enhanced with better monitoring.

We empirically test our theoretical predictions using two different specifications on a sample of $42,506$ firm-years. We find strong evidence of a positive relation between cash holdings and our monitoring proxy, analyst coverage; but obtain contradictory results regarding our two entrenchment proxies. When we restrict our sample, consistently with our model's implications, to on-average profitable firms we find strong results corroborating our theoretical predictions.

A Appendix

A.1 Solution for principal-run firm

In the absence of a cost-of-carry, shareholders are indifferent between keeping cash in or out of the firm. Thus, in our setup the principal-run firm would have no reason to pay out cash, as every additional dollar of cash reduces the probability of incurring refinancing costs. Setting the cost-of-carrying cash to zero, the cash inventory (3) evolves according to

$$dC_t = [\mu + r(C_t - d)]\, dt + \sigma dW_t + dE_t \tag{9}$$

In the region where no equity issuance occurs, the value of the principal-run firm's equity, denoted as $L(\cdot)$, obeys at time t

$$L(t) = e^{-rdt}\,[L(t + dt)] \tag{10}$$

Using Taylor's expansion, the right-hand side obtains

$$L = (1 - rdt)\left[L + \frac{\partial L}{\partial C} dC + \frac{1}{2}\frac{\partial^2 L}{\partial C^2}(dC)^2 + \dots\right] \tag{11}$$

where the subscripts denote partial derivatives, and terms that have dt raised at a power higher than 1 are omitted. Substituting () into () obtains

$$\frac{1}{2}\sigma^2 L_{CC} + [\mu + r(C_t - d)]\, L_C - rL = 0 \tag{12}$$

The general solution to this differential equation is

$$L(C) = \left(\frac{\mu}{r} + C - d\right)\left[B_1 - B_2\left(\frac{e^{-\frac{[\mu + r(C-d)]^2}{r\sigma^2}}}{r\,[\mu + r(C - d)]} + \frac{\sqrt{\pi}\ \mathrm{erf}\left(\frac{\mu + r(C-d)}{\sqrt{r}\sigma}\right)}{r^{3/2}\sigma}\right)\right] \tag{13}$$

where B_1 and B_2 are constants, and $erf(\cdot)$ represents the Gauss error function.

We determine the value of the constants using two conditions. Since shareholders incur no cost from keeping cash into the firm, the marginal value of cash is always higher than one. In the limit, the probability of incurring refinancing costs becomes zero and the marginal value of an additional dollar of cash becomes one. Thus,

$$\lim_{C\to\infty} L_C(C) = 1. \tag{14}$$

When the firm runs out of cash, shareholders need to replenish its cash reserves by an amount m. Since there is no marginal cost of issuing equity, shareholders will inject such a quantity of cash up to the point where its marginal value becomes one. In our setup, this amount is infinite. Nevertheless, this does not affect the solution of our model. We write the second condition as

$$L(0) = \lim_{m\to\infty} [L(m) - m] - \phi. \tag{15}$$

Substituting (13) into (14) and (15) obtains

$$B_1 = 1 - \frac{\phi}{\frac{\mu - rd}{r}\left[1 - \mathrm{erf}\left(\frac{\mu - rd}{\sqrt{r}\sigma}\right)\right] - \frac{\sigma}{\sqrt{r\pi}} e^{-\left(\frac{\mu - rd}{\sqrt{r}\sigma}\right)^2}}$$

$$B_2 = -\frac{r^2\phi}{\sqrt{\pi}\frac{\mu - rd}{\sqrt{r}\sigma}\left[1 - \mathrm{erf}\left(\frac{\mu - rd}{\sqrt{r}\sigma}\right)\right] - e^{-\left(\frac{\mu - rd}{\sqrt{r}\sigma}\right)^2}}$$

Substituting back into (13) and simplifying obtains equation (6).

A.2 Solution for agent-run firm

As in Bolton, Chen, and Wang (2009), we distinguish three regions depending on the level of the state variable, C_t. These are:

1. the external funding region,
2. the inaction region, and
3. the payout region.

Assume the level of the firm's cash holdings are such that the firm is in the inaction region. If in the next time increment dt the firm remains in the inaction region, shareholders have only capital gains, and, similar to the principal-run firm, we can write the value to shareholders, $S(\cdot)$, as

$$S = (1 - rdt)\left[S + \frac{\partial S}{\partial C}dC + \frac{1}{2}\frac{\partial^2 S}{\partial C^2}(dC)^2 + \dots\right] \tag{16}$$

Expanding and substituting (3) into (16) obtains the following differential equation

$$\frac{1}{2}\sigma^2 S_{CC} + \left[\mu_1 + (r-\theta)C_t\right]S_C - rS = 0 \tag{17}$$

that defines the value to shareholders. The general solution to this differential equation is

$$\begin{aligned} S(C_t) =& e^{\frac{C_t(2dr - rC_t + C_t\theta - 2\mu_1)}{\sigma^2}}\left[H_{\frac{\theta-2r}{r-\theta}}\left(\frac{-dr + rC_t - C_t\theta + \mu_1}{\sigma\sqrt{r-\theta}}\right)A_1 + \right. \\ & \left. {}_1F_1\left(\frac{2r-\theta}{2r-2\theta}; \frac{1}{2}; \frac{(-dr + C_t r - C_t\theta + \mu_1)^2}{(r-\theta)\sigma^2}\right)A_2\right] \end{aligned} \tag{18}$$

where $H_n(x)$ is the n^{th} Hermite polynomial of x, ${}_1F_1(a;b;z)$ is the Kummer confluent hypergeometric function, and A_1 and A_2 are constants that need to be determined with the help of the problem's boundary conditions.

The intuition of our paper is that shareholders will dispose of the manager as soon as the added value he offers to the firm is offset by the value destroyed by him. Given the absence of an outside option, the manager will behave in such a way that ensures this will never occur. In terms of his objective function (4), he chooses $\overline{C}_1$ in such a way that τ^L becomes infinite. In our model, the managerial influence is restricted to the payout policy of the firm, i.e. the determination of $\overline{C}_1$, which is one of the four unknowns that need to be determined in this section (together with A_1, A_2, and m).

The first condition that the agent-run shareholders' value function, $S(C)$, has to satisfy is

$$S_C(\overline{C}_1) = 1. \tag{19}$$

In the absence of payout costs, $\overline{C}_1$ is a reflecting barrier of C. The interpretation of this Smooth-Pasting condition is simply that every amount of cash above the payout threshold is paid to shareholders, and thus increases the value of shareholders by the same amount. When the firm runs out of cash, shareholders replenish the firm's cash reserves up to m_1 incurring a fixed cost ϕ. We can formulate the second boundary condition for this case as

$$S(0) = S(m_1) - (m_1 + \phi) \tag{20}$$

which simply indicates that the shareholders' value when the firm's cash has run out is equal to their value after the firm has replenished their cash inventory minus the amount paid (cash injected plus costs of financing). When shareholders decide the amount to be issued, they do so in an optimal way. The appropriate smooth-pasting condition that ensures this optimality is

$$S_C(m_1) = 1. \tag{21}$$

Finally, the manager has to make sure that his position is safe; this will be true as long as the shareholders' value of an agent-run firm is higher or equal to their value in a similar principal-run firm. The final condition is thus

$$S(C_t) \geq L(C_t). \tag{22}$$

For our quantitative analysis, we use values for which the inequality binds only once at $C_t = \overline{C}_1$.

A.3 Long-run distribution of cash

Our variable of interest in this project is the firm's cash stock. We follow Bertola and Caballero (1990) to derive the long-run distribution of a particle following a Brownian Motion, like accumulated cash in our case. For ease of presentation, we assume in this section that $\theta = r$ and $d = 0$. The results can be easily replicated for different assumptions.

Similar to standard textbook approach, we use binomial trees to approximate the Brownian Motion. We divide the entire space $(0; \overline{C})$ into intervals equal to $dc = \sigma\sqrt{dt}$.

The more dc and dt approach to zero, the closer this approximation converges to a Brownian Motion. Within the space $[dc; \overline{C} - dc]$ and for every time t the particle can move either up or down by dc. It is easy to show that the probability of an upward and this of a downward movement are respectively

$$\begin{aligned} p &= \tfrac{1}{2}\left(1 + \mu \tfrac{dt}{dc}\right) \\ q &= \tfrac{1}{2}\left(1 - \mu \tfrac{dt}{dc}\right) \end{aligned} \tag{23}$$

We model the long-run distribution of cash, for it does not depend on the initial state of the particle. After a long period of time T, the particle (cash) can be at any point c in the $(0; \overline{C}]$ interval. It may have moved to c following either an upward movement from $c - dc$ or a downward movement from $c + dc$. Thus, if $f(c)$ is the density function of long-term cash, it holds that

$$f(c) = pf(c - dc) + qf(c + dc) \tag{24}$$

Substituting (23) and rearranging obtains

$$\begin{gathered} [f(c) - f(c - dc)] - [f(c + dc) - f(c)] \\ +\mu \tfrac{dt}{dc}\left[[f(c + dc) - f(c)] + [f(c) - f(c - dc)]\right] = 0 \end{gathered} \tag{25}$$

Dividing both sides by $(dc)^2$ and taking to the limit gives

$$\frac{1}{2}\sigma^2 f_{cc}(c) + \mu f_c(c) = 0 \tag{26}$$

The general solution of this differential equation is

$$f(c) = Xe^{\xi c} + Y \tag{27}$$

where X and Y are constants to be determined, and $\xi = \frac{2\mu}{\sigma}$.

In the case of a resetting barrier, the distribution is still continuous but not continuously differentiable at m. This gives

$$f(C) = \begin{cases} X_1 e^{\xi C} + Y_1, & \text{if } C \leq m_1 \\ X_2 e^{\xi C} + Y_2, & \text{if } C \geq m_1 \end{cases} \tag{28}$$

where X_1, X_2, Y_1, and Y_2 are constants to be determined.

In order to find the values of the constants, we make use of the distribution conditions. Using continuity at d, the first condition is

$$\lim_{c \to m^-} f(c) = \lim_{c \to m^+} f(c) \tag{29}$$

For the second condition, we assume that the lower threshold at $c = 0$ is never hit so that

$$f(0) = 0 \tag{30}$$

The resetting barrier m can be reached in three ways: an upward movement from $m - dc$, a downward movement from $m + dc$, or a jump following a downward movement from dc. Thus, we can write

$$f(m) = pf(m - dc) + qf(m + dc) + qf(dc) \tag{31}$$

Making use of both (23) and (30), and rearranging, we obtain

$$\begin{gathered} f(m) - f(m - dc) = [f(m + dc) - f(m)] + [f(dc) - f(0)] \\ -\mu \tfrac{dt}{dc} \left[[f(m + dc) - f(m)] - [f(m) - f(m - dc)] - [f(dc) - f(0)] \right] \end{gathered} \tag{32}$$

Dividing by dc and taking to the limit, the third condition can be expressed as

$$\lim_{c \to m^-} f'(c) = \lim_{c \to m^+} f'(c) + \lim_{c \to 0^+} f'(c) \tag{33}$$

The upper threshold $\overline{C}$ is a reflecting barrier which can be reached in two ways, either by following an upward movement from $\overline{C} - dc$ or from staying at the threshold (when the particle is at point $\overline{C}$ at time $T - dt$, it stays there with a probability p). Thus,

$$f(\overline{C}) = pf(\overline{C} - dc) + pf(\overline{C}) \tag{34}$$

Substituting the binomial probabilities obtains

$$f(\overline{C}) - f(\overline{C} - dc) = \mu \frac{dt}{dc} \left[f(\overline{C}) + f(\overline{C} - dc) \right] \tag{35}$$

Dividing both sides by dc, making use of the fact that $(dc)^2 = \sigma dt$, and taking to the limit, we reach our fourth condition

$$\lim_{c \to \overline{C}^-} f'(c) = \xi f(\overline{C}) \tag{36}$$

Finally, we complete the conditions with the sum of probabilities constraint

$$\int_0^{\overline{C}} f(c)\, \mathrm{d}c = 1 \tag{37}$$

Although our system seems to be overdetermined, in fact two conditions coincide and a closed-form solution can easily be derived for the long-run distribution. Namely,

$$f(c) = \begin{cases} \psi(e^{\xi c} - 1), & \text{if } c \leq m \\ \psi(1 - e^{-\xi m}) e^{\xi c}, & \text{if } c \geq m \end{cases} \tag{38}$$

where

$$\psi = \frac{\xi}{e^{\xi \overline{C}} - e^{\xi(\overline{C} - m)} - \xi m}$$

Integrating over the interval $(0, \overline{C}]$, the long-term average cash is equal to

$$\begin{aligned} \overline{c} &= \int_0^m \psi c(e^{\xi c} - 1)\, \mathrm{d}c + \int_m^{\overline{C}} \psi(1 - e^{-\xi m}) c e^{\xi c}\, \mathrm{d}c = \\ &= -\frac{\psi e^{-m\xi} \left((2 - 2\overline{C}\xi) e^{\xi(m + \overline{C})} + m\xi e^{m\xi}(m\xi - 2) + 2e^{\overline{C}\xi}(\overline{C}\xi - 1) \right)}{2\xi^2} = \\ &= \frac{(1 - \overline{C}\xi) e^{\xi(m + \overline{C})} + m\xi e^{m\xi}(\frac{m\xi}{2} - 1) + e^{\overline{C}\xi}(\overline{C}\xi - 1)}{\xi \left(-e^{\xi(m + \overline{C})} + m\xi e^{m\xi} + e^{\overline{C}\xi} \right)} \end{aligned} \tag{39}$$

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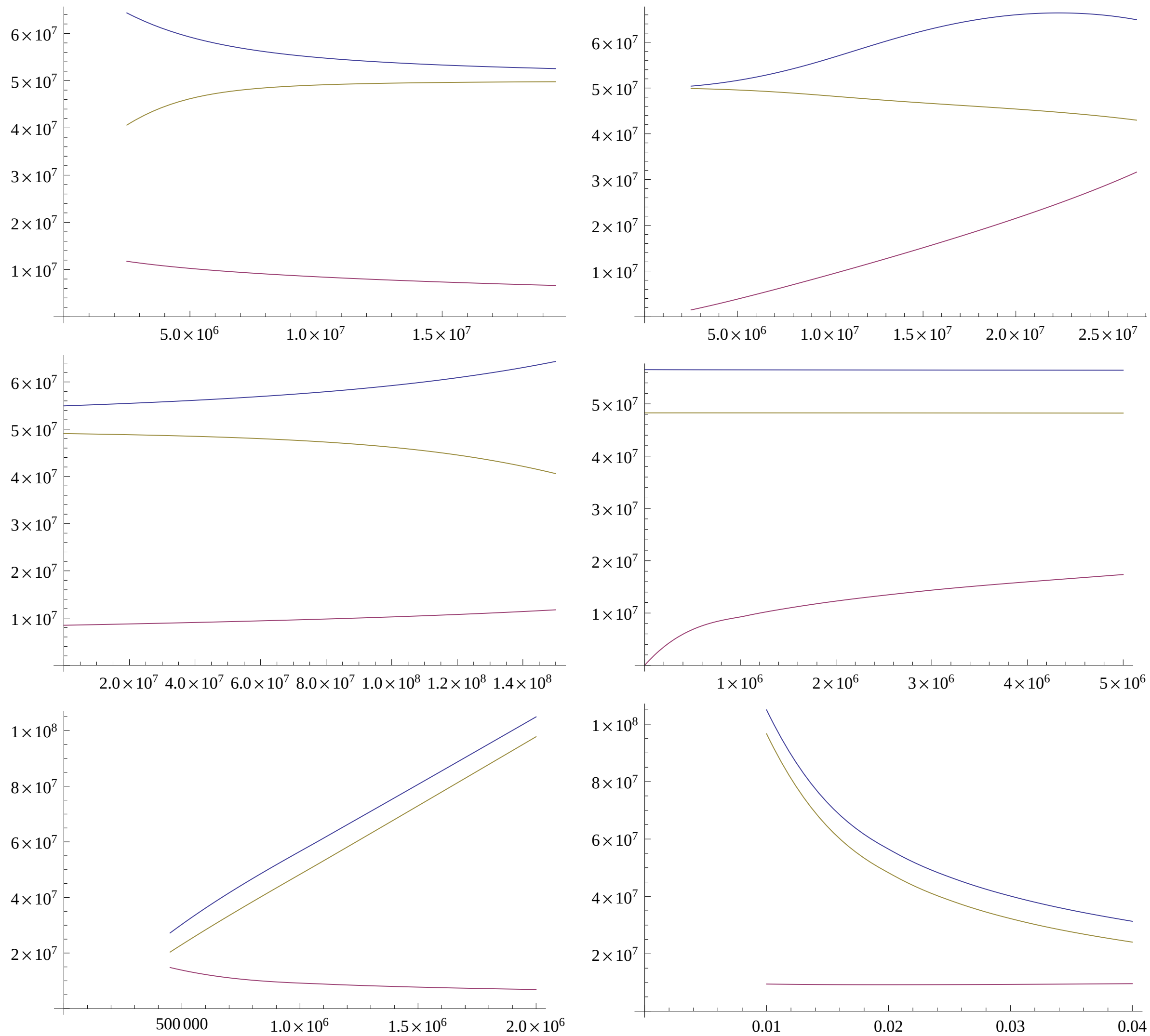

Figure 1: The relation between the parameters of our model and corporate cash policy. For every panel, the blue line represents the upper threshold at which payout occurs, $\overline{C}_1$; the purple line represents the resetting barrier, m_1, which is the amount of equity shareholders are willing to inject into the firm when it runs out of cash; the yellow line represents the average of the stationary distribution of cash holdings based on the cash accumulation rate (see equation (3)) and both the upper and resetting barriers. The vertical axis in all panels represents cash holdings. The horizontal axis represents operating cash flow in the top left panel, operating cash flow volatility in the top right panel, debt in the middle left panel, refinancing costs in the middle right panel, entrenchment in the bottom left panel, and the inverse of monitoring in the bottom left panel.

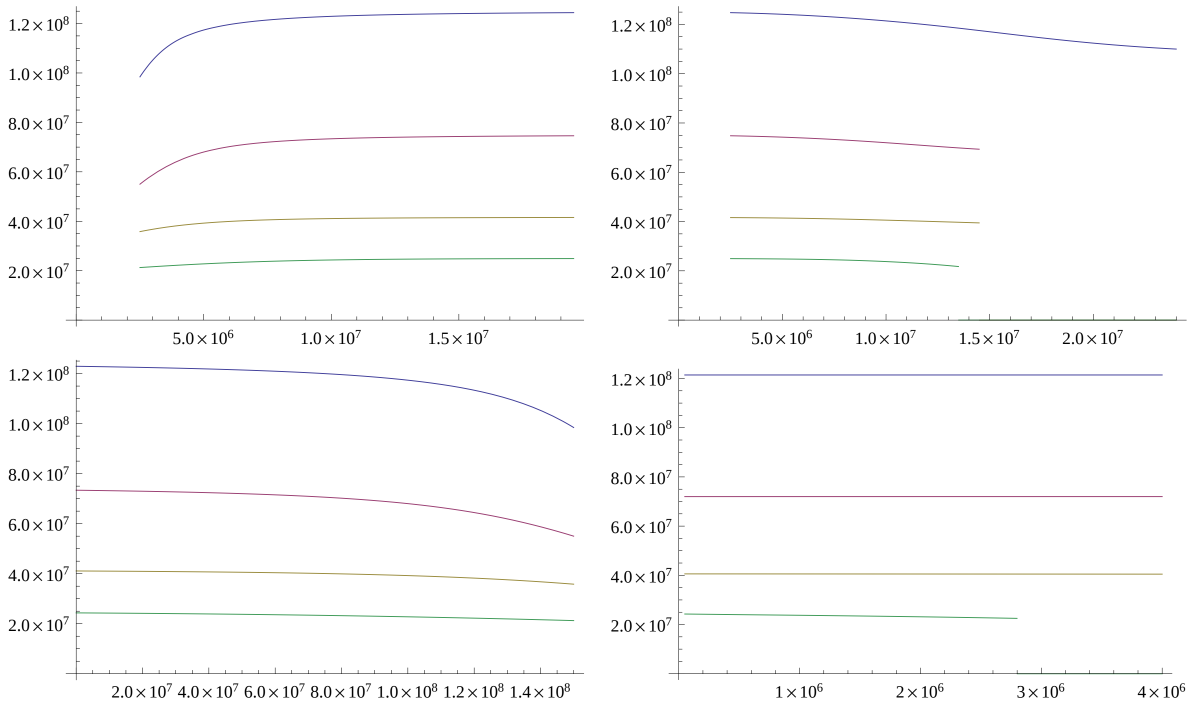

Figure 2: The relation between the parameters of our model and average long-term cash holdings for different levels of monitoring and entrenchment. For every panel, the blue line represents a firm with good monitoring and high entrenchment ($GMHE$); the purple line a firm with good monitoring and low entrenchment ($GMLE$); the yellow line a firm with bad monitoring and high entrenchment ($BMHE$); and the green line a firm with bad monitoring and low entrenchment ($BMLE$). As in Figure 1, the vertical axis in all panels represents cash holdings. The horizontal axis represents operating cash flow in the top left panel, operating cash flow volatility in the top right panel, debt in the bottom left panel, refinancing costs in the bottom right panel.

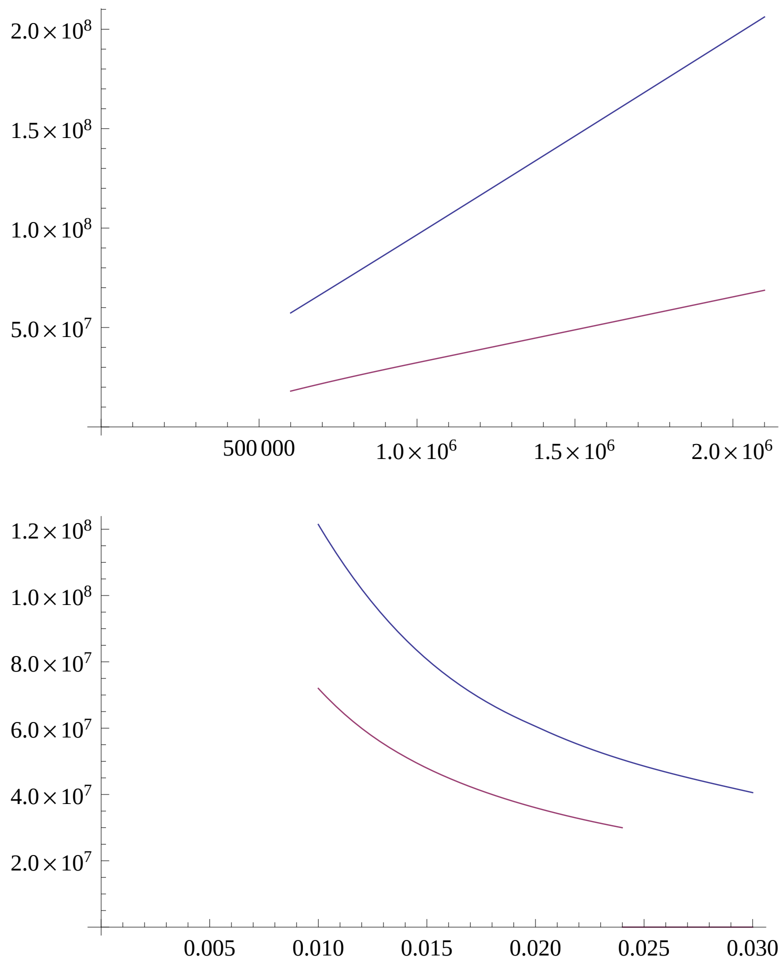

Figure 3: The relation between the parameters of our model and average long-term cash holdings for different levels of monitoring and entrenchment. The vertical axis in both panels represents cash holdings. On the top panel, the blue line represents firms with good monitoring, whereas the purple line represents firms with bad monitoring; the horizontal axis represents managerial entrenchment. On the bottom panel, the blue line represents firms with more entrenched managers and the purple line firms with less entrenched managers; the horizontal axis represents parameter θ (inverse of monitoring).

Table 1: **Variable definitions**

This table collects the definitions of all the variables included in this study.

Variable	Definition
Cash Holdings	Ratio of cash holdings and marketable securities over book value of total assets
Firm CF	Ratio of operating income before depreciation minus total income taxes over net assets (total assets minus cash and marketable securities
Industry CF	Median *Firm CF* for firms in the same industry, as defined by the two-digit SIC code
Excess CF	The difference between *Firm CF* and *Industry CF*
CF Volatility	Mean of the standard deviations of *Firm CF* over ten years for firms operating in the same industry
Leverage	Ratio of the sum of long-term and short-term debt over book value of total assets
Size	Natural logarithm of the book value of total assets
Analyst Coverage	Square root of the number of analysts following the firm's stock
Delaware95	Dummy variable taking the value of one if both the firm is operating in the state of Delaware and the fiscal year is post-1995
Capital Expenditures	Ratio of capital expenditures over the book value of total assets
Market-to-Book	Ratio of the book value of assets minus the book value of equity plus the market value of equity, over book value of total assets
Net Working Capital	Ratio of net working capital minus cash and marketable securities, over book value of total assets
R&D	Ratio of R&D expenditures over sales
Acquisition Spending	Ratio of acquisitions expenditures over the book value of total assets
Dividend Dummy	Dummy variable taking the value of one if the firm paid a dividend during the year and the value of zero otherwise

Table 2: **Descriptive statistics**

The variables described are: the ratio of cash and marketable securities over book total assets, the ratio of operating income before depreciation but after taxes over net assets, the median of the latter by industry, the difference between the two, the volatility of the industry cash flow ratio, the ratio of total debt over total assets, the book value of total assets, the number of analysts following a firm's stock, a dummy variable capturing firms both incorporated in the state of Delaware and fiscal years after 1995, the ratio of capital expenditures over the book value of total assets, the ratio of the market value of equity plus the book value of debt over the book value of assets, the ratio of net working capital minus cash and marketable securities over book value of total assets, the ratio of R&D expenditures over sales, the ratio of acquisitions expenditures over the book value of total assets, and a dividend dummy variable. Net assets are equal to total assets minus cash and marketable securities. All variables except analyst coverage are trimmed at the 0.5% level on either tail.

Panel A: Our full sample consists of $42,506$ firm-years from $6,238$ unique firms covering fiscal years from 1990 to 2008.

Variable	Mean	Median	Standard Deviation	25^{th} Percentile	75^{th} Percentile
Cash Holdings	0.181	0.092	0.208	0.024	0.275
Firm CF	0.037	0.117	0.418	0.066	0.167
Industry CF	0.088	0.097	0.048	0.080	0.116
Excess CF	-0.051	0.017	0.408	-0.032	0.074
CF Volatility	0.308	0.211	0.270	0.108	0.464
Leverage	0.203	0.170	0.192	0.019	0.464
Assets	1,448	253	4,113	79	907
Analysts Following	7.567	5	7.830	2	10
Delaware95	0.490	0	0.500	0	1
Capital Expenditures	0.066	0.045	0.066	0.024	0.081
Market-to-Book	2.068	1.557	1.621	1.157	2.338
Net Working Capital	0.101	0.090	0.177	-0.014	0.215
R&D	0.148	0.004	0.744	0	0.078
Acquisition Spending	0.026	0	0.063	0	0.017
Dividend Dummy	0.321	0	0.467	0	1

Table 2 — **continued**

Panel B: Descriptive statistics of sample restricted to profit-making firms (5-year average cash flow higher than or equal to zero). The restricted sample consists of $36,238$ firm-years from $5,222$ unique firms covering fiscal years from 1990 to 2008.

Variable	Mean	Median	Standard Deviation	25^{th} Percentile	75^{th} Percentile
Cash Holdings	0.138	0.068	0.164	0.020	0.202
Firm CF	0.136	0.128	0.102	0.089	0.175
Median Industry CF	0.094	0.099	0.042	0.083	0.117
Excess CF	0.042	0.027	0.108	-0.011	0.083
Industry's CF Volatility	0.275	0.194	0.249	0.101	0.400
Leverage	0.216	0.193	0.189	0.037	0.339
Assets	1,663	330	4,408	106	1,119
Analysts Following	8.059	5	8.062	2	11
Delaware95	0.459	0	0.498	0	1
Capital Expenditures	0.068	0.048	0.066	0.027	0.084
Market-to-Book	1.893	1.194	1.342	1.136	2.146
Net Working Capital	0.123	0.112	0.169	0.006	0.232
R&D	0.037	0	0.078	0	0.041
Acquisition Spending	0.028	0	0.065	0	0.022
Dividend Dummy	0.375	0	0.484	0	1

Table 3: **Regression Results of Excess CF specification**

This table presents the results of our first specification. The dependent variable is the ratio of cash and marketable securities on total assets for all columns. Model I presents the results of the regression on the full sample. Models II to VI present results on the restricted sample. Models III to V exclude variables of interest to check for the robustness of our results. Model VI uses industry fixed effects, where the industry is defined by the two-digit SIC code.

Variable	I	II	III	IV	V	VI
Constant	0.345***	0.266***	0.262***	0.245***	0.294***	0.234***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Industry CF	-0.434***	0.017	0.006	0.047**	-0.186***	0.118***
	(0.000)	(0.444)	(0.776)	(0.034)	(0.000)	(0.000)
Excess CF	-0.149***	0.143***	0.305***	0.333***		0.150***
	(0.000)	(0.000)	(0.000)	(0.000)		(0.000)
Industry Risk	0.122***	0.069***	0.070***	0.072***	0.082***	0.064***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Leverage	-0.359***	-0.314***	-0.316***	-0.339***	-0.338***	-0.284***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Size	-0.030***	-0.022***	-0.023***	-0.012***	-0.025***	-0.018***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	
Analyst Coverage	0.029***	0.015***	0.018***		0.023***	0.012***
	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)
Analyst Cov*Ex CF	0.000	0.068***				0.065***
	(0.811)	(0.000)				(0.000)
N	42,506	36,238	36,238	36,238	36,238	36,238
$\overline{R}^2$	0.424	0.322	0.318	0.307	0.285	0.386

Table 4: **Regression Results of Delaware 95 specification**

This table presents the results of our second specification. The dependent variable is the ratio of cash and marketable securities on total assets for all columns. Model I presents the results of the regression on the full sample. Models II to VI present results on the restricted sample. Models III to V exclude variables of interest to check for the robustness of our results. Model VI uses industry fixed effects, where the industry is defined by the two-digit SIC code.

Variable	I	II	III	IV	V	VI
Constant	0.360***	0.279***	0.279***	0.268***	0.279***	0.274***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cash Flow	-0.077***	0.330***	0.330***	0.336***	0.329***	0.327***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Delaware	-0.002	-0.004*	-0.004*	-0.005*		-0.003
	(0.532)	(0.079)	(0.078)	(0.059)		(0.153)
Year95	0.000	0.005**	0.005**	0.001		0.004*
	(0.927)	(0.015)	(0.015)	(0.677)		(0.070)
Delaware95	0.015***	0.008**	0.008***	0.009***		0.010***
	(0.000)	(0.025)	(0.003)	(0.002)		(0.005)
Industry Risk	0.067***	0.011***	0.011***	0.011***	0.015***	0.025***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Leverage	-0.344***	-0.270***	-0.270***	-0.279***	-0.272***	-0.262***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Size	-0.025***	-0.019***	-0.019***	-0.014***	-0.018***	-0.019***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Analyst Coverage	0.021***	0.009***	0.009***		0.008***	0.009***
	(0.000)	(0.000)	(0.000)		(0.000)	(0.000)
An Cov*Del95	0.001	0.000				-0.001
	(0.544)	(0.938)				(0.253)

(cont.)

Table 4 — **continued**

Variable	I	II	III	IV	V	VI
Capital Expenditures	-0.571***	-0.511***	-0.511***	-0.486***	-0.511***	-0.446***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Market-to-Book	0.020***	0.010***	0.010***	0.012***	0.010***	0.010***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Net Working Capital	-0.297***	-0.258***	-0.258***	-0.257***	-0.259***	-0.278***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R & D Expenses	0.030***	0.602***	0.602***	0.621***	0.602***	0.551***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Acquisitions	-0.278***	-0.237***	-0.237***	-0.231***	-0.231***	-0.232***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Dividend Dummy	-0.049***	-0.033***	-0.033***	-0.035***	-0.035***	-0.026***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
N	42,506	36,238	36,238	36,238	36,238	36,238
$\overline{R}^2$	0.552	0.528	0.528	0.525	0.527	0.546