External Monitoring, Managerial Entrenchment and Corporate Cash Holdings*

Shantanu Banerjee† Panagiotis Couzoff†‡ Grzegorz Pawlina†

10th May 2012

Abstract

Corporate governance has long been demonstrated to affect corporate cash holdings. Still, the evidence of the direction of the relationship is at best mixed. In this paper, we disentangle two key aspects of corporate governance: monitoring and managerial entrenchment, which affect its quality in opposite directions. We develop a model of delegated cash management where the level of monitoring and managerial entrenchment are explicitly accounted for. Considering that internal monitoring mechanisms might be significantly affected by a manager's influence, we test our predictions on a large sample of US data using external indicators of monitoring. Our results support our theoretical predictions and indicate that *both* the level of external monitoring as well as managerial entrenchment positively affect cash holdings. Given that the former is synonymous with lower agency costs and the latter with higher ones, our results provide, among others, an explanation as to why aggregate proxies for the quality of corporate governance are unlikely to capture its effect on cash holdings.

*We thank seminar participants at Lancaster University for helpful comments and suggestions.
†Department of Accounting and Finance, Lancaster University Management School, LA1 4YX, UK.
‡Corresponding author: p.couzoff1@lancaster.ac.uk

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 they must be viewed by their employers, the firm's shareholders, as at least as good an alternative as the managers who can be hired in the labor market. The quality of corporate governance determines how effectively managerial actions can be monitored and how costly it is to eject a manager if it is optimal to do so. In this paper, we attempt to disentangle these two aspects of corporate governance (*external monitoring* and *managerial entrenchment*) and examine their distinct effects on corporate cash holding policy. As a high level of external monitoring (managerial entrenchment) is associated with a high (low) quality of corporate governance and both variables have a positive effect on cash holdings, we are able to explain why aggregate measures of the quality of corporate governance have been rather unsuccessful in capturing the governance-cash holdings relationship.

Cash holdings of listed US firms have increased sharply over the last 25 years. Naturally, this liquidity boom has attracted an increasing interest of contemporaneous financial research. 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. 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.

Although the effect of governance on corporate performance and valuation is still debated upon,[1] there seems to be a wider consensus in the literature regarding the effect of governance on the *value* of cash holdings. 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

[1] A non-extensive list of references would include Gompers, Ishii, and Metrick (2003), Core, Guay, and Rusticus (2006), Bhagat and Bolton (2008), Bebchuk, Cohen, and Ferrell (2009).

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.

Interestingly, unlike the afore-mentioned convergence of results on the effect of corporate governance on the value of cash, the relation between corporate governance indicators and the *level* of cash a firm chooses to hold is far from clear. Opler, Pinkowitz, Stulz, and Williamson (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. Harford, Mansi, and Maxwell (2008) report that the opposite is true for US firms, where poorly governed firms have lower 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 in an attempt to capture these two components of the principal-agent conflict in a simple, yet meaningful, way. The model

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

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 is able to extract more perquisites from the firm's cash flow *when* the level of accumulated cash holdings is higher. The manager's hoarding propensity is mitigated by the fact that shareholders hold a right to dismiss him at any time they wish to do so. Better monitoring reduces the proportion of perquisites that the manager can extract, while managerial entrenchment makes the shareholders' outside option less valuable relative to the current condition. The manager exercises such a liquidity policy that guarantees his job security – a solution that is in line with Faleye's (2004) observation that despite proxy contests being such a powerful mechanism of corporate control, there are only so few of them recorded. We predict that both better monitoring and higher entrenchment, albeit notions that would cancel each other out in firm-specific indicators of agency costs, both positively affect corporate cash holdings.

Our model has common roots with Bolton, Chen, and Wang (2011), but serves a different purpose. While their study focuses on the investment-financing decision, our paper targets to incorporate agency considerations in the firm's liquidity policy. Our model bears similarities with Nikolov and Whited (2011), who also focus on the relation of agency conflicts and corporate cash holdings. In their model, the manager trades off the opportunity to tunnel some of the firm's cash to his own benefit at a given point in time against investing and benefiting from higher cash flows (and thus higher accumulated cash holdings) at a future date. However, their model does not incorporate shareholders' intervention to dismiss the manager if the latter deviates from their tolerance levels, which is how our model defines the upper boundary of the distribution of cash holdings.

We empirically test the predictions of our model on a large sample of US firms. Considering that firm-specific variables of agency costs might be significantly affected by a manager's influence, our challenge is to pinpoint variables that could capture managerial entrenchment and monitoring beyond his power. Regarding monitoring, we search for external mechanisms in order to avoid issues of the "who controls the controllers" type, which are more often than not present in internal monitoring devices.

Our first proxy for monitoring is a measure of analyst coverage of the firm's stock. As a second proxy, we make use of the firm's stock bid-ask spread as an indication of the perceived transparency of the firm's operations. For our entrenchment variables, we first use managerial performance in accordance with our model, which we proxy by the firm's cash flow in excess of the industry median cash flow. As a second variable, we model managerial entrenchment as an exogenous cost of firing the manager, where we make use of the manager-friendly legal framework of the state of Delaware. 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 our empirical approach, whereas the results of tests of our model's predictions are discussed in Section 4. Section 5 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 arithmetic 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

[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.

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 no lump sum cost of paying out cash to equityholders, the upper barrier, $\overline{C}$, is a reflecting barrier ($\nu = 0$). In other words, the firm pays out to equityholders anything above $\overline{C}$, every time this barrier is hit. The lower threshold $\underline{C}$ is set to 0, such that the firm seeks external financing whenever it runs out of cash. Thus, the liquidity policy of our firm is in fact reduced 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 have the choice between running the company themselves and appointing 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 at any time they wish to do so.

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 do so. The shareholders' objective function can thus be expressed 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 (A.1), we derive the value of the "principal-run" firm to be equal to

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

where

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

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.

To illustrate the effect of the two corporate governance variables, we subsequently 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.

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*.

[4]The interested reader can find the solution of the model in the Appendix (A.2).

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 from low levels, 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 further, 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.

[Insert Figure 1 about here]

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, on average, 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, 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), $BMHE$

[5]The derivation of the ergodic distribution, and the calculation of average cash holdings can be found in the Appendix (A.3).

(bad monitoring, high entrenchment, yellow line), and $BMLE$ (bad monitoring, low entrenchment, green line).

[Insert Figure 2 about here]

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 for all cases.

[Insert Figure 3 about here]

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.

3 Empirical methodology

This section describes the empirical testing of our theoretical results. We first state our predictions based on our model as developed in the previous section, then describe the variables and data used, and expose the main specification of our empirical study.

3.1 Hypothesis development

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

Hypothesis 1: Corporate cash holdings increase with managerial entrenchment.
Managerial entrenchment makes shareholders' outside option, i.e. the option to manage the firm themselves, less valuable relative to the value of the firm. Managers take advantage by keeping more cash into the firm, and thus extracting more perquisites from shareholders' wealth over time.

Hypothesis 2: Corporate cash holdings increase with monitoring.
Better monitoring assures shareholders of getting a higher 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).

3.2 Variables

We follow our theoretical model for the construction of our empirical specifications. 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 measures for most of our parameters can be easily constructed, 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 distinguish. Although commonly used firm-specific measures of corporate governance, such as the Governance Index (Gompers et al., 2003), the Entrenchment Index[6] (Bebchuk et al., 2009), or board independence, may be successful in capturing effects of governance on the value of the firm, they are not able to distinguish between the desired effects of our study.

Firm-specific governance variables can be interpreted alternatively as higher managerial entrenchment or lower monitoring. According to our model higher entrenchment leads to higher cash holdings, while lower monitoring has the opposite effect. The determinants of their cross-sectional variation are very difficult, if at all possible, to control for. It could easily be the case that entrenchment and monitoring jointly determine these variables, and not necessarily in a straightforward way. In addition, the indices are a mere sum of antitakeover dummies which is also rather constant over time (they are renewed every two to three years), making them subject to high measurement error. Hence, the interpretation of their effect on liquidity could be problematic. To mitigate these issues, we try to pinpoint below some more exogenous variables that should be able to capture these two effects.

[6]These indices consist of 24 and 6 antitakeover provisions respectively that protect the board of directors, and ultimately the management team from hostile takeover attempts.

3.2.1 Monitoring

Albeit not widely used in cash holdings studies,[7] we consider the number of analysts following the stock price of a firm to be a suitable variable for capturing external monitoring. 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 (Chengi and Subramanyam 2008, Yu 2008). 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 effect of an additional analyst is probably decreasing with the number of analysts following, we use the square root of the number of analysts following a firm's stock per fiscal year.

Following the same rationale, we use a proxy of information asymmetry as our second proxy for external monitoring. Transparency of a firm's operations is a major determinant of the bid-ask spread of a firm's stock; the risk of adverse selection makes the less informed parties to ask for a higher bid-ask spread in order to be compensated for this risk (Copeland and Galai 1983). The more scrutinized a firm is, and thus more transparent, the lower the bid-ask spread of its stock. We construct this variable as the average relative bid-ask spread of a stock over its fiscal year. We multiply this average by minus one to make the interpretation of our interaction variables more straightforward.

3.2.2 Entrenchment

Our next concern is to find variables that would be able to capture managerial entrenchment. For our first variable, we follow closely our theoretical model. We break

[7] Analyst coverage is used as a measure of information asymmetry in Kalcheva and Lins (2007) and Denis and Sibilkov (2010).

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 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 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. The excess cash flow is simply the difference between the firm's cash flow and the industry median.

For our second variable, we examine managerial entrenchment as the cost of firing a manager. Given that we would like our variable to be independent of the firm's monitoring mechanisms, we employ US corporate legislation concerning hostile takeovers. Previous literature (Bebchuk and Cohen 2005, Low 2009) pinpoints two court rulings[8] passed in the state of Delaware during 1995 which made hostile takeovers more difficult to succeed, and, consequently, managers' position safer. The safer 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 accumulation process (3), an increase in the upper threshold eventually leads to higher average cash holdings.[9] We use these rulings as a positive exogenous shock to the cost of replacing the manager,

[8]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 the target's right to a poison pill, although the bidder had already been tendered 75% of the target's shares.

[9]The refinancing barrier will also be affected by this cost, but we expect the effect of its change on the average cash to be negligible.

and therefore construct as our second entrenchment variable a dummy taking the value of one for firms incorporated in Delaware and for years after 1995, and the value of zero otherwise.

3.2.3 Controls

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 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.

[Insert Table 1 about here]

Although we abstain from formulating hypotheses for their coefficients for the aforementioned reasons, we include some commonly used agency costs variables as controls. These are: the $GIndex$, or alternatively the $Eindex$ plus the difference between the $GIndex$ and the $EIndex$, the size of the board of directors, the independence of the board, and a dummy ($CEO/ChairmanDuality$) if the CEO is also the chairman of the board for this fiscal year. The description of the variables used throughout this study are summarized in Table 1.

3.3 Specification

Defining $CashHoldings$ as the ratio of cash and marketable securities over book assets, our specification can be expressed as

$$\begin{aligned} Cash\ Holdings_{it} = \alpha_0 &+ \alpha_1 Monitoring_{it} + \alpha_2 Entrenchment_{it} + \\ &+ \alpha_3 Monitoring_{it} * Entrenchment_{it} + \alpha_4 Industry\ CF_{it} + \\ &+ \alpha_5\ CFVolatility_{it} + \alpha_6 Leverage_{it} + \alpha_7 Size_{it} + \\ &+ \sum \beta * Controls_{it} + \psi_i + \epsilon_{it} \end{aligned} \tag{7}$$

Our coefficients of main interest are α_1 and α_2, which capture the effects of monitoring and entrenchment respectively. According to our predictions, we expect both these coefficients to be positive and significant. We include an interaction variable to test for *Hypothesis 3*, that the effect of entrenchment is magnified with monitoring. Hence, we expect α_3 to be positive as well. We also expect α_4 to be positive, reflecting the positive effect of an increase in μ. Opposite to common predictions and findings of previous literature, we expect α_5 to be negative, reflecting the downward slope of average cash holdings in Figure 1. Furthermore, we expect the coefficient α_6 to be negative, and α_7 not to be significant.[10]

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 some endogeneity issues with these control variables, the main purpose of this study is to add some explanatory variables to extant literature by isolating external monitoring and managerial entrenchment. Lastly, considering that there might be additional industry factors other than industry cash flow and industry cash flow volatility that affect the level of cash holdings, we use industry fixed effects for all our tests, captured by ψ_i in (7).

[10]Since size may also capture some economies of scale, we do not exclude the possibility of α_7 being negative.

3.4 Data

We collect our data from various sources. We collect financial information data from Standard & Poor's Compustat Fundamentals Annual files, analyst coverage data from Thomson Reuters' Institutional Broker's Estimate System (I/B/E/S) database, bid-ask spreads from the Center for Research in Security Prices (CRSP), and corporate governance variables from Risk Metrics. 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. We truncate all firm-specific ratios by 0.5% on each side for our estimates not to be affected by outliers. We merge the data from the afore-mentioned databases and retain firm-years that have at least one monitoring and one entrenchment data item. Due to different sources of data, we have unequal samples for our different tests. The largest sample consists of $60,724$ firm-years from $8,968$ unique firms for fiscal years between 1990 and 2009.

[Insert Table 2 about here]

The descriptive statistics of our sample are provided in Panel A of Table 2. Our dependent variable, cash holdings ratio, has mean value of 0.183, median value of 0.101, and standard deviation of 0.205, reflecting its high variation. The firms in our sample have on average 5.48 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 10% of its assets in cash and cash equivalents, has an operating income of 10.5% over its net assets (or 9.45% over its total assets), a cash flow volatility of 28%, a leverage ratio of 17%, a capital expenditure ratio of 4.2%, a market-to-book ratio of 1.47, a net working capital ratio of 8% (18% including cash and cash equivalents), a R&D expenditure of 0.2% of its sales, makes no acquisitions, and

pays no dividends. The median firm also has adopted 9 out of the 24 IRRC provisions, and 2 out of the 6 included in Bebchuk's (2009) $EIndex$. Finally, the board of the firm consists of 9 members, 6 of which are classified as independent.

4 Results

This section reports the results of our empirical analysis. We separate our results with respect to the variable used to proxy for entrenchment into two tables. In Table 3, we present the results of our first specification, using the excess cash flow as a proxy for entrenchment, and analyst coverage and modified bid-ask spread as proxies for monitoring alternatively. Columns I and II provide the relation between cash holdings and our explanatory variables for the full sample.[11] In accordance with our predictions, we find that cash holdings ratio increases with analyst coverage and transparency, and decreases with leverage and size. However, our predictions about the effect of entrenchment, industry profitability, and volatility are not validated. In models III and IV, we incorporate some additional corporate governance variables which make our results more consistent with our predictions.[12] Namely, the entrenchment variable is still negative but insignificant when analyst coverage is used as a monitoring proxy, and positive and significant when the bid-ask spread is used instead. The intersection terms of monitoring and entrenchment are positive and significant in both cases.

[Insert Table 3 about here]

We repeat the same tests substituting the excess cash flow variable with the $Delaware$ 1995 dummy as an entrenchment variable, capturing the manager-friendly legal environment as discussed above. The results are presented in Table 4. In order to eliminate individual effects of either the state of Delaware or the large time period (post-1995), when a large increase in cash holdings has been evidenced to occur (Bates et al., 2009),

[11] As mentioned above, the sample size varies with the monitoring variable used.

[12] The sample is significantly reduced due to the availability of governance data (limited number of large US firms for a 10-year period, from 1996 to 2006).

we also include a dummy taking a value of one for firms operating in the state of Delaware and zero otherwise, and a second dummy for all fiscal years after the law inception. The results suggest that all else equal, firms operating in Delaware after 1995 hold on average $2-3\%$ more cash than the rest of the sample, and that this effect is not due to either the state of Delaware nor the time period alone. Furthermore, the effect of our external monitoring variables remain positive in both cases, and the intersection term is positive and significant in the case of the bid-ask spread measure, but not in the case of analyst coverage.

[Insert Table 4 about here]

Overall, our results indicate that the effect of both monitoring variables is consistently positive. Regarding the entrenchment variables, although the effect of the Delaware Legislation dummy is positive, this is not the case for the excess cash flow, especially so when additional corporate governance factors are not controlled for (Models I and II of Table 3). We suspect that the results could be driven by some extremely low values of cash flow, as mentioned in section 3.4, where our model might no longer hold. Our theoretical model is based on the assumption that the expected cash flows of the firm are positive. To check whether our results are driven by negative values of cash flows, we 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 $60,724$ to $49,208$ observations. The descriptive statistics of this restricted sample are exposed in Panel B of Table 2.

Table 5 presents the results using the restricted sample. We find strong positive relations between our variables of main interest and the level of cash holdings. For on-average profitable firms, both monitoring and entrenchment have a positive effect on the level of cash a firm chooses to hold. Furthermore, cash holdings are higher for smaller firms, with lower leverage, which operate in riskier and more profitable

industries. Finally, the positive coefficient of most interaction terms indicates that the effect of entrenchment is enhanced when better monitoring is in place.

[Insert Table 5 about here]

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 consider this finding to be more compatible with the short-run distribution of cash. The significant movements of both the upper threshold and the refinancing barrier lead to an increase in cash holdings in the short run. Furthermore, 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 reality, however, the manager has a variety of decisions to make. 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 even more cash. 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.

5 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 pairs of proxies on a sample of US firms. Consistent with our predictions, we find substantial evidence of a positive relation between cash holdings and our proxies for external monitoring and managerial entrenchment, indicating that aggregate corporate governance measures may not be able to fully capture the multitude of effects they in fact encompass.

A Appendix

A.1 Liquidation function

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

$$dC_t = [\mu + r\,(C_t - d)]\,dt + \sigma dW_t + dE_t \tag{A.8}$$

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

$$L(t) = e^{-rdt}\,[L(t + dt)] \tag{A.9}$$

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

$$L = (1 - rdt)\left[L + \frac{\partial L}{\partial C}dC + \frac{1}{2}\frac{\partial^2 L}{\partial C^2}(dC)^2 + \ldots\right] \tag{A.10}$$

where the subscripts denote partial derivatives, and terms that have dt raised at a power higher than 1 are omitted. Substituting (A.8) into (A.10) obtains

$$\frac{1}{2}\sigma^2 L_{CC} + [\mu + r\,(C_t - d)]\,L_C - rL = 0 \tag{A.11}$$

The general solution to this differential equation is

$$L(C) = \left(\frac{\mu}{r} + C - d\right)\left[B_1 - B_2\left(\frac{e^{-\frac{[\mu + r(C-d)]^2}{r\sigma^2}}}{r\,[\mu + r(C-d)]} + \frac{\sqrt{\pi}\ \mathrm{erf}\left(\frac{\mu + r(C-d)}{\sqrt{r}\sigma}\right)}{r^{3/2}\sigma}\right)\right] \tag{A.12}$$

where B_1 and B_2 are constants, and $\mathrm{erf}(\cdot)$ 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,

$$\lim_{C\to\infty} L_C(C) = 1. \tag{A.13}$$

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

$$L(0) = \lim_{m\to\infty} [L(m) - m] - \phi. \tag{A.14}$$

Substituting (A.12) into (A.13) and (A.14) obtains

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

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

Substituting back into (A.12) and simplifying obtains equation (6).

A.2 Value of agent-run firm

As in Bolton, Chen, and Wang (2011), 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

$$S = (1 - rdt)\left[S + \frac{\partial S}{\partial C}dC + \frac{1}{2}\frac{\partial^2 S}{\partial C^2}(dC)^2 + \ldots\right] \tag{A.15}$$

Expanding and substituting (3) into (A.15) obtains the following differential equation

$$\frac{1}{2}\sigma^2 S_{CC} + \left[\mu_1 + (r-\theta)C_t\right]S_C - rS = 0 \tag{A.16}$$

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

$$\begin{aligned} S(C_t) =& e^{\frac{C_t(2dr - rC_t + C_t\theta - 2\mu_1)}{\sigma^2}}\left[H_{\frac{\theta-2r}{r-\theta}}\left(\frac{-dr + rC_t - C_t\theta + \mu_1}{\sigma\sqrt{r-\theta}}\right)A_1 + \right. \\ & \left. {}_1F_1\left(\frac{2r-\theta}{2r-2\theta}; \frac{1}{2}; \frac{(-dr + C_t r - C_t\theta + \mu_1)^2}{(r-\theta)\sigma^2}\right)A_2\right] \end{aligned} \tag{A.17}$$

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

$$S_C(\overline{C}_1) = 1. \tag{A.18}$$

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

$$S(0) = S(m_1) - (m_1 + \phi) \tag{A.19}$$

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

$$S_C(m_1) = 1. \tag{A.20}$$

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

$$S(C_t) \geq L(C_t). \tag{A.21}$$

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 start by assuming that $\theta = r$ and $\delta = d = 0$. 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 $(0; \overline{C}_1)$ 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 $[dc; \overline{C}_1 - dc]$ 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

$$\begin{aligned} p &= \tfrac{1}{2}\left(1 + \mu\tfrac{dt}{dc}\right) \\ q &= \tfrac{1}{2}\left(1 - \mu\tfrac{dt}{dc}\right) \end{aligned} \tag{A.22}$$

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 $(0; \overline{C}_1]$ 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

$$f(c) = pf(c - dc) + qf(c + dc) \tag{A.23}$$

Substituting (A.22) and rearranging obtains

$$\begin{aligned} &[f(c) - f(c - dc)] - [f(c + dc) - f(c)] \\ &+\mu\tfrac{dt}{dc}\left[[f(c + dc) - f(c)] + [f(c) - f(c - dc)]\right] = 0 \end{aligned} \tag{A.24}$$

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

$$\frac{1}{2}\sigma^2 f_{cc}(c) + \mu f_c(c) = 0 \tag{A.25}$$

The general solution of this differential equation is

$$f(c) = Xe^{\xi c} + Y \tag{A.26}$$

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 con-

tinuously differentiable at m_1. This gives

$$f(C) = \begin{cases} X_1 e^{\xi C} + Y_1, & \text{if } C \leq m_1 \\ X_2 e^{\xi C} + Y_2, & \text{if } C \geq m_1 \end{cases} \tag{A.27}$$

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

$$\lim_{c \to m_1^-} f(c) = \lim_{c \to m_1^+} f(c) \tag{A.28}$$

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

$$f(0) = 0 \tag{A.29}$$

The resetting barrier m_1 can be reached in three ways: an upward movement from $m_1 - dc$, a downward movement from $m_1 + dc$, or a jump following a downward movement from dc. Thus, we can write

$$f(m_1) = pf(m_1 - dc) + qf(m_1 + dc) + qf(dc) \tag{A.30}$$

Making use of both (A.22) and (A.29), and rearranging, we obtain

$$\begin{gathered} f(m_1) - f(m_1 - dc) = [f(m_1 + dc) - f(m_1)] + [f(dc) - f(0)] \\ -\mu \tfrac{dt}{dc} \left[[f(m_1 + dc) - f(m_1)] - [f(m_1) - f(m_1 - dc)] - [f(dc) - f(0)] \right] \end{gathered} \tag{A.31}$$

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

$$\lim_{c \to m_1^-} f'(c) = \lim_{c \to m_1^+} f'(c) + \lim_{c \to 0^+} f'(c) \tag{A.32}$$

The upper threshold $\overline{C}_1$ is a reflecting barrier which can be reached in two ways, either by following an upward movement from $\overline{C}_1 - dc$ or from staying at the threshold (when

the particle is at point $\overline{C}_1$ at time $T - dt$, it stays there with a probability p). Thus,

$$f(\overline{C}_1) = pf(\overline{C}_1 - dc) + pf(\overline{C}_1) \tag{A.33}$$

Substituting the binomial probabilities obtains

$$f(\overline{C}_1) - f(\overline{C}_1 - dc) = \mu \frac{dt}{dc} \left[f(\overline{C}_1) + f(\overline{C}_1 - dc) \right] \tag{A.34}$$

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

$$\lim_{c \to \overline{C}_1^-} f'(c) = \xi f(\overline{C}_1) \tag{A.35}$$

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

$$\int_0^{\overline{C}_1} f(c)\, \mathrm{d}c = 1 \tag{A.36}$$

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,

$$f(c) = \begin{cases} \psi(e^{\xi c} - 1), & \text{if } c \leq m_1 \\ \psi(1 - e^{-\xi m_1}) e^{\xi c}, & \text{if } c \geq m_1 \end{cases} \tag{A.37}$$

where

$$\psi = \frac{\xi}{e^{\xi \overline{C}_1} - e^{\xi(\overline{C}_1 - m_1)} - \xi m_1}$$

Integrating over the interval $(0, \overline{C}_1]$, the long-term average cash is equal to

$$\begin{aligned} \overline{c} &= \int_0^{m_1} \psi c (e^{\xi c} - 1)\, \mathrm{d}c + \int_{m_1}^{\overline{C}_1} \psi (1 - e^{-\xi m_1}) c e^{\xi c}\, \mathrm{d}c = \\ &= \frac{(1 - \overline{C}_1 \xi) e^{\xi(m_1 + \overline{C}_1)} + m_1 \xi e^{m_1 \xi} (\frac{m_1 \xi}{2} - 1) + e^{\overline{C}_1 \xi} (\overline{C}_1 \xi - 1)}{\xi \left(-e^{\xi(m_1 + \overline{C}_1)} + m_1 \xi e^{m_1 \xi} + e^{\overline{C}_1 \xi} \right)} \end{aligned} \tag{A.38}$$

In our case, where $\theta \neq r$, $\delta \neq 0$, and $d \neq 0$, the differential equation (A.25) becomes

$$\frac{1}{2}\sigma^2 f_{cc}(c) - [\mu + \delta - rd + (r-\theta)c] f_c(c) - (r-\theta) f(c) = 0$$

and its general solution is

$$f(c) = e^{\frac{[2(\mu+\delta-rd)+(r-\theta)c]c}{\sigma^2}} X + \frac{\sqrt{\pi}}{2} \frac{e^{\frac{[\mu+\delta-rd+(r-\theta)c]^2}{(r-\theta)\sigma^2}} \text{Erf}\left[\frac{\mu+\delta-rd+(r-\theta)c}{\sqrt{r-\theta}\sigma}\right] \sigma}{\sqrt{r-\theta}} Y$$

The same steps as above are followed to estimate the long-term average cash. Unlike the simplified case, no closed-form solution exists, and $\bar{c}$ is solved for numerically.

References

Bates, T. W., K. M. Kahle, and R. M. Stulz (2009): "Why do US firms hold so much more cash than they used to?," *The Journal of Finance*, 64(5), 1985–2021.

Bebchuk, L. A., and A. Cohen (2005): "The costs of entrenched boards," *Journal of Financial Economics*, 78(2), 409–433.

Bebchuk, L. A., A. Cohen, and A. Ferrell (2009): "What matters in corporate governance?," *Review of Financial Studies*, 22(2), 783.

Bertola, G., and R. J. Caballero (1990): "Kinked adjustment costs and aggregate dynamics," *NBER Macroeconomics Annual*, 5, 237–288.

Bhagat, S., and B. Bolton (2008): "Corporate governance and firm performance," *Journal of Corporate Finance*, 14(3), 257–273.

Bolton, P., H. Chen, and N. Wang (2011): "A unified theory of Tobin's q, corporate investment, financing, and risk management," *The Journal of Finance*, 66(5), 1545–1578.

Chengi, M., and K. Subramanyam (2008): "Analyst Following and Credit Ratings," *Contemporary Accounting Research*, 25(4), 1007–1044.

Copeland, T. E., and D. Galai (1983): "Information Effects on the Bid-Ask Spread," *The Journal of Finance*, 38(5), pp. 1457–1469.

Core, J. E., W. R. Guay, and T. O. Rusticus (2006): "Does weak governance cause weak stock returns? An examination of firm operating performance and investors' expectations," *The Journal of Finance*, 61(2), 655–687.

Denis, D. J., and V. Sibilkov (2010): "Financial constraints, investment, and the value of cash holdings," *Review of Financial Studies*, 23(1), 247.

Dittmar, A., and J. Mahrt-Smith (2007): "Corporate governance and the value of cash holdings.," *Journal of Financial Economics*, 83(3), 599 – 634.

Dittmar, A., J. Mahrt-Smith, and H. Servaes (2003): "International Corporate Governance and Corporate Cash Holdings.," *Journal of Financial and Quantitative Analysis*, 38(1), 111 – 133.

Dixit, A. K. (1993): *The art of smooth pasting (Fundamentals of pure and applied economics vol. 55)*. Harwood Academic Publishers, Amsterdam.

Faleye, O. (2004): "Cash and corporate control," *The Journal of Finance*, 59(5), 2041–2060.

Gompers, P., J. Ishii, and A. Metrick (2003): "Corporate governance and equity prices," *Quarterly Journal of Economics*, 118(1), 107–155.

Harford, J., S. A. Mansi, and W. F. Maxwell (2008): "Corporate governance and firm cash holdings in the US," *Journal of Financial Economics*, 87(3), 535–555.

Jensen, M. C. (1986): "Agency costs of free cash flow, corporate finance, and takeovers," *The American Economic Review*, 76(2), 323–329.

Jensen, M. C., and W. H. Meckling (1976): "Theory of the firm: Managerial behavior, agency costs and ownership structure," *Journal of Financial Economics*, 3(4), 305–360.

Kalcheva, I., and K. V. Lins (2007): "International evidence on cash holdings and expected managerial agency problems," *Review of Financial Studies*, 20(4), 1087.

Low, A. (2009): "Managerial risk-taking behavior and equity-based compensation," *Journal of Financial Economics*, 92(3), 470–490.

Nikolov, B., and T. M. Whited (2011): "Agency Conflicts and Cash: Estimates from a Structural Model," *SSRN eLibrary*.

Opler, T., L. Pinkowitz, R. Stulz, and R. Williamson (1999): "The determinants and implications of corporate cash holdings," *Journal of Financial Economics*, 52(3), 46.

Pinkowitz, L., R. Stulz, and R. Williamson (2006): "Does the Contribution of Corporate Cash Holdings and Dividends to Firm Value Depend on Governance? A Cross-country Analysis," *The Journal of Finance*, 61(6), 2725–2751.

Shleifer, A., and R. W. Vishny (1997): "A Survey of Corporate Governance," *The Journal of Finance*, 52(2), 737–783.

Yu, F. (2008): "Analyst coverage and earnings management," *Journal of Financial Economics*, 88(2), 245 – 271.

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
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
Analyst Coverage	Square root of the number of analysts following the firm's stock
Transparency	Minus mean bid-ask spread of the firm's stock during the fiscal year
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
G Index	Index summing 24 dummies representing antitakeover provisions that have been adopted by a firm
E Index	Index consisting of only 6 out of the above 24 antitakeover provisions
Board Size	Number of directors the board consists of
Board Independence	Proportion of directors of the board that are neither employed nor linked to the firm
CEO/Chairman duality	Dummy taking the value of one if the CEO is also the chairman of the board

Table 2: **Descriptive statistics**

Descriptive statistics of the variables defined in Table 1. All variables are trimmed at the 0.5% level on either tail.
Panel A: Our full sample consists of 60,724 firm-years from 8,968 unique firms covering fiscal years from 1990 to 2009.

Variable	Obs	Mean	Median	Standard Deviation	25^{th} Percentile	75^{th} Percentile
Cash Holdings	60,724	0.184	0.101	0.205	0.027	0.277
Firm CF	60,724	0.012	0.108	0.435	0.042	0.161
Industry CF	60,724	0.082	0.095	0.057	0.075	0.115
Excess CF	60,724	-0.070	0.011	0.424	-0.051	0.072
CF Volatility	60,724	0.418	0.282	0.399	0.136	0.573
Leverage	60,724	0.204	0.169	0.193	0.020	0.331
Assets	60,724	1,332	162	4,044	44.3	711
Capital Expenditures	60,724	0.061	0.042	0.062	0.022	0.077
Market-to-Book	60,724	1.97	1.48	1.55	1.1	2.23
Net Working Capital	60,724	0.091	0.080	0.189	-0.027	0.212
R & D	60,724	0.135	0.002	0.635	0	0.073
Acquisitions	60,724	0.023	0	0.057	0	0.011
Dividend dummy	60,724	0.289	0	0.453	0	1
Analysts Following	46,143	7.37	5	7.72	2	10
Mean bid-ask spread	60,724	0.035	0.020	0.043	0.007	0.045
Delaware 1995	54,832	0.488	0	0.500	0	1
G Index	14,409	9.21	9	2.69	7	11
E Index	14,409	2.22	2	1.28	1	3
Board size	10,342	8.92	9	2.44	7	10
Board independence	10,342	0.633	0.667	0.181	0.500	0.778
CEO/Chairman duality	11,608	0.363	0	0.481	0	1

Panel B: Descriptive statistics of sample restricted to on-average profit making firms (5-year average cash flow higher than or equal to zero). The restricted sample consists of 49,208 firm-years from 7,288 unique firms covering fiscal years from 1990 to 2009.

Variable	Obs	Mean	Median	Standard Deviation	25^{th} Percentile	75^{th} Percentile
Cash Holdings	49,208	0.142	0.075	0.163	0.022	0.208
Firm CF	49,208	0.128	0.123	0.106	0.081	0.172
Median Industry CF	49,208	0.089	0.098	0.050	0.079	0.116
Excess CF	49,208	0.039	0.025	0.114	-0.016	0.085
Average CF volatility	49,208	0.378	0.250	0.379	0.119	0.521
Leverage	49,208	0.218	0.195	0.190	0.038	0.344
Assets	49,208	1,609.7	240.78	4,436.9	67.903	971.73
Capital Expenditure	49,208	0.064	0.045	0.062	0.024	0.081
Market-to-Book	49,208	1.788	1.415	1.248	1.08	2.034
Net working capital	49,208	0.117	0.107	0.178	-0.004	0.232
R & D	49,208	0.034	0	0.073	0	0.035
Acquisitions	49,208	0.025	0	0.060	0	0.016
Dividend dummy	49,208	0.353	0	0.478	0	1
Analysts Following	39,427	7.84	5	7.96	2	11
Mean bid-ask spread	49,208	0.032	0.018	0.041	0.006	0.041
Delaware 1995	44,331	0.460	0	0.498	0	1
G Index	13,737	9.26	9	2.7	7	11
E Index	13,737	2.23	2	1.28	1	3
Board size	9,934	8.98	9	2.44	7	11
Board independence	9,934	0.633	0.667	0.180	0.500	0.778
CEO/Chairman duality	11,200	0.364	0	0.481	0	1

Table 3: **Results of Excess CF Specification**

This table presents the results of regressions using cash flow in excess of the industry median as a proxy for entrenchment. The dependent variable is the ratio of cash and marketable securities on total assets for all columns. Monitoring is proxied by analyst coverage in Models I and III, and by a measure of transparency (minus mean bid-ask spread) in Models II and IV. Models III and IV incorporate additional corporate governance variables. The definitions of variables used are given in Table 1. Although included, the coefficients of industry fixed effects, defined by the two-digit SIC code, and a constant term are not reported. t-statistics are reported in brackets.

Variable	I	II	III	IV
Analyst Coverage	0.013***		0.016***	
	(19.45)		(10.97)	
Transparency		0.537***		1.057***
		(29.25)		(10.39)
Excess CF	-0.039***	-0.084***	-0.004	0.066***
	(-11.05)	(-37.31)	(-0.22)	(5.26)
Analyst Coverage*Excess CF	-0.020***		0.021***	
	(-11.89)		(3.94)	
Transparency*Excess CF		-0.285***		2.514***
		(-8.67)		(3.96)
Industry CF	-0.181***	-0.136***	-0.059	-0.137***
	(-10.32)	(-8.49)	(-1.46)	(-3.39)
CF Volatility	0.019***	0.003	0.021***	0.005
	(7.87)	(1.41)	(4.69)	(1.13)
Leverage	-0.340***	-0.368***	-0.251***	-0.254***
	(-87.13)	(-104.78)	(-30.17)	(-29.81)
Size	-0.016***	-0.009***	-0.028***	-0.021***
	(-28.86)	(-20.86)	(-18.13)	(-16.55)
Capital Expenditures	-0.443***	-0.394***	-0.693***	-0.629***
	(-36.86)	(-36.47)	(-24.07)	(-21.75)
Market-to-Book	0.020***	0.016***	0.012***	0.013***
	(43.27)	(37.45)	(10.32)	(12.20)
Net Working Capital	-0.333***	-0.276***	-0.362***	-0.369***
	(-72.63)	(-72.41)	(-35.17)	(-35.45)
R & D	0.037***	0.037***	0.100***	0.098***
	(28.84)	(32.03)	(19.92)	(19.97)
Acquisitions	-0.283***	-0.284***	-0.296***	-0.302***
	(-25.94)	(-27.24)	(-14.86)	(-14.89)
Dividend	-0.043***	-0.043***	-0.032***	-0.033***
	(-26.96)	(-28.78)	(-11.52)	(-11.64)
E Index			-0.005***	-0.006***
			(-4.72)	(-5.76)
G Index - E Index			-0.002***	-0.002***
			(-3.35)	(-2.92)
Board Size			-0.007***	-0.007***
			(-10.81)	(-11.46)
Board Independence			0.000	-0.011
			(0.01)	(-1.42)
CEO/Chairman			-0.009***	-0.005*
			(-3.56)	(-1.93)
Observations	46143	60724	8296	8269
Adjusted R^2	0.562	0.513	0.562	0.549

Table 4: **Results of Delaware Legislation Specification**

This table presents the results of regressions using a dummy taking the value of one for firm-years in Delaware post-1995 and zero otherwise as a proxy for entrenchment. The dependent variable is the ratio of cash and marketable securities on total assets for all columns. Monitoring is proxied by analyst coverage in Model *I* and by a measure of transparency (minus mean bid-ask spread) in Model *II*. The definitions of the remaining variables are given in Table 1. Although included, the coefficients of industry fixed effects, defined by the two-digit SIC code, and a constant term are not reported. *t*-statistics are reported in brackets.

Variable	I	II
Analyst Coverage	0.020***	
	(21.49)	
Transparency		0.509***
		(23.61)
Delaware post-1995	0.019***	0.031***
	(4.61)	(9.62)
Analyst Coverage*Delaware 1995	-0.001	
	(-0.80)	
Transparency*Delaware 1995		0.328***
		(10.56)
Delaware	0.001	-0.002
	(0.20)	(-0.62)
Post-1995	0.003	-0.012***
	(1.17)	(-4.88)
Industry CF	-0.180***	-0.165***
	(-9.48)	(-9.35)
CF Volatility	0.016***	-0.001
	(6.18)	(-0.25)
Leverage	-0.330***	-0.365***
	(-79.96)	(-98.45)
Size	-0.027***	-0.015***
	(-39.49)	(-31.37)
Capital Expenditures	-0.494***	-0.429***
	(-38.35)	(-36.84)
Market-to-Book	0.018***	0.016***
	(36.14)	(35.35)
Net Working Capital	-0.360***	-0.311***
	(-76.20)	(-78.36)
R & D	0.059***	0.059***
	(50.19)	(55.82)
Acquisitions	-0.298***	-0.295***
	(-25.97)	(-26.84)
Dividend	-0.041***	-0.042***
	(-23.91)	(-25.74)
Observations	42318	54832
Adjusted R^2	0.558	0.505

Table 5: **Results for Restricted Sample**

This table presents the results of our previous tests on the restricted sample. The dependent variable is the ratio of cash and marketable securities on total assets for all columns, monitoring is proxied by either analyst coverage (Models I and II) or a measure of transparency (minus mean bid-ask spread) (Models III and IV), and entrenchment by either the cash flow ratio in excess of the industry median (Models I and III) or a dummy taking a the value of one for firm-years in Delaware post-1995 and zero otherwise (Models II and IV). The definitions of the remaining variables are given in Table 1. Although included, the coefficients of industry fixed effects, defined by the two-digit SIC code, and a constant term are not reported. t-statistics are reported in brackets.

Variable	I	II	III	IV
Analyst Coverage	0.003***	0.011***		
	(4.55)	(13.21)		
Transparency			0.369***	0.385***
			(21.68)	(18.79)
Excess CF	0.275***		0.326***	
	(25.37)		(45.96)	
Delaware post-1995		0.010***		0.014***
		(2.67)		(5.07)
Analyst Coverage*Excess CF	0.017***			
	(4.37)			
Analyst Coverage*Delaware 1995		-0.001		
		(-0.95)		
Transparency*Excess CF			1.238***	
			(10.29)	
Transparency*Delaware 1995				0.189***
				(6.13)
Delaware		-0.003		-0.004
		(-1.21)		(-1.51)
Post-1995		0.003		-0.007***
		(1.18)		(-3.16)
Industry CF	0.233***	-0.009	0.224***	-0.023
	(12.87)	(-0.47)	(13.40)	(-1.26)
CF Volatility	0.013***	0.015***	0.004*	0.004*
	(6.10)	(6.47)	(1.85)	(1.92)
Leverage	-0.272***	-0.279***	-0.287***	-0.296***
	(-75.75)	(-72.64)	(-87.50)	(-84.74)
Size	-0.015***	-0.020***	-0.016***	-0.016***
	(-28.96)	(-31.92)	(-38.83)	(-35.94)
Capital Expenditures	-0.442***	-0.433***	-0.441***	-0.414***
	(-40.56)	(-36.56)	(-44.28)	(-38.23)
Market-to-Book	0.009***	0.020***	0.008***	0.018***
	(17.52)	(38.19)	(15.57)	(36.95)
Net Working Capital	-0.281***	-0.284***	-0.268***	-0.265***
	(-64.47)	(-61.13)	(-71.44)	(-65.58)
R & D	0.558***	0.464***	0.584***	0.505***
	(62.38)	(49.96)	(68.22)	(56.27)
Acquisitions	-0.247***	-0.260***	-0.244***	-0.251***
	(-26.16)	(-26.03)	(-27.05)	(-26.16)
Dividend	-0.026***	-0.023***	-0.021***	-0.019***
	(-19.39)	(-15.30)	(-16.67)	(-13.68)
Observations	39427	36023	49208	44331
Adjusted R^2	0.532	0.513	0.498	0.476

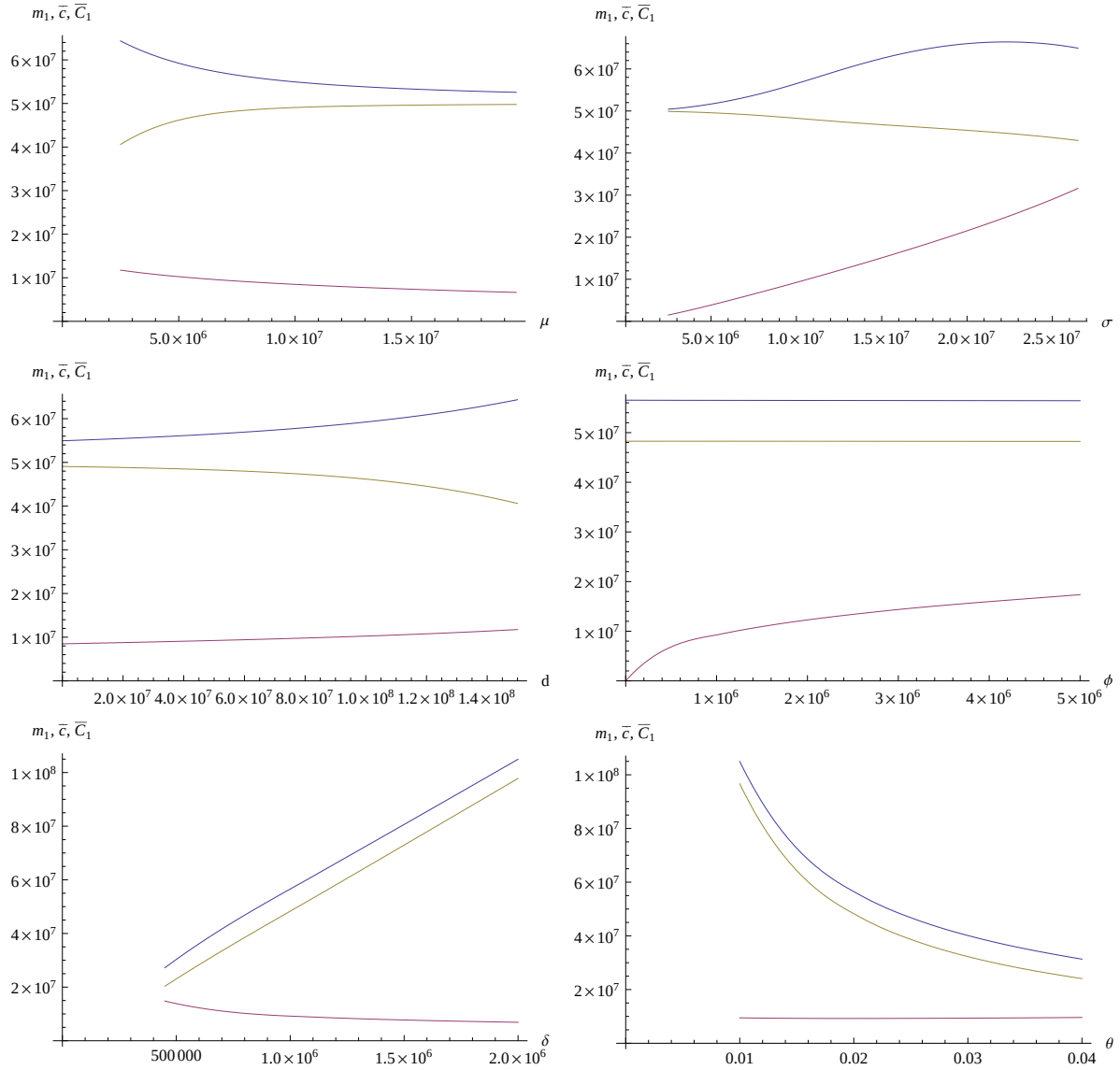

Figure 1: The relation between the parameters of our model and corporate cash policy. For every panel, the blue line represents the upper threshold at which payout occurs, $\overline{C}_1$; the purple line represents the resetting barrier, m_1, which is the amount of equity shareholders are willing to 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.

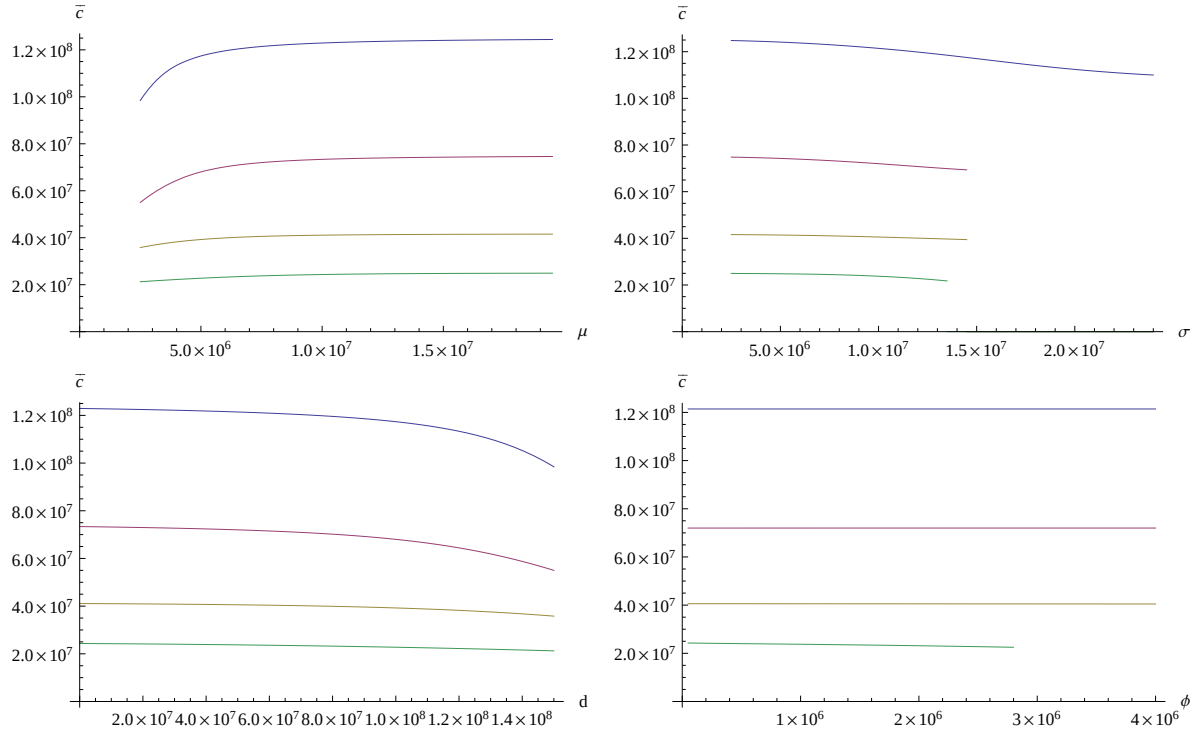

Figure 2: The relation between the parameters of our model and average long-term cash holdings for different levels of monitoring and entrenchment. For every panel, the blue line represents a firm with good monitoring and high entrenchment ($GMHE$); the purple line a firm with good monitoring and low 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.

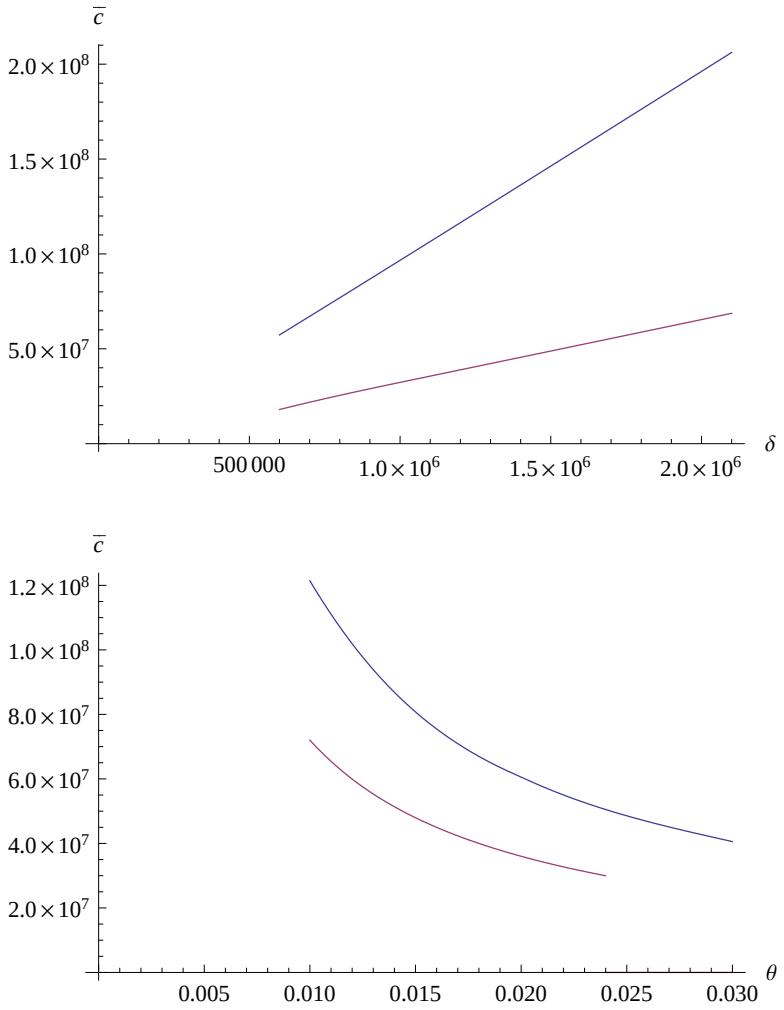

Figure 3: The relation between the parameters of our model and average long-term cash holdings for different levels of monitoring and entrenchment. The vertical axis in both panels represents cash holdings. On the top panel, the blue line represents firms with good monitoring, whereas the purple line 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).