Abstract. We study the relation between firm cash policy and stock returns when there exists agency conflicts using a structural model. We find that firms with more misaligned manager-shareholder incentives tend to hold more cash and invest more. Meanwhile, they have lower profitability and perform worse. If an investor ignores the agency costs within such firms, she will overprice the stock and suffers a loss. Using a data set of U.S. public firms, we find empirical evidence consistent with the model’s predictions.

JEL Classification: D21, E24, G12, G32

Keywords: cash holding, agency costs, investment, cross-sectional stock returns
I. Introduction

In recent decades, U.S. firms are holding considerably more cash than ever before. According to Bates, Kahle, and Stulz (2009), the average cash-to-asset ratio of U.S. firms has doubled in 26 years, from 10.5% in 1980 to 23.2% in 2006. However, it is not yet clear that how would a firm’s cash holding policy relate with its stock return. On the one hand, retaining cash and other liquid assets improves a firm’s financial flexibility. It helps avoid costly external financing when a desirable investment opportunity arises, which increases firm value (Gamba and Triantis 2008; Riddick and Whited 2009) and drive up stock returns (Palazzo 2012). On the other hand, hoarding too much cash without good investment opportunity or distribution signals possible agency problems in a firm (Jensen 1986), which hurts firm value and deteriorates its stock return.\(^1\)

Although empirical evidence generally supports that there is a positive relation between agency conflicts and firm cash holding (Harford 1999; Dittmar, Mahrt-Smith, and Servaes 2003; Dittmar and Mahrt-Smith 2007) and a negative relation between agency costs and firm value (Harford 1999; Harford, Mansi, and Maxwell 2008), not much theory has yet been developed to quantify the link among the three.

We enter this picture with a dynamic model that directly links them. Following the spirit of Hennessy and Whited (2005, 2007), the backbone of our model features endogenous investment, financing and distribution. Motivated by various empirical evidence\(^2\) we introduce agency frictions by assuming that managers choose cash and investment policies to maximize their own discounted cash flows, which are different from those received by other shareholders. Under this setting, different compensation structures could create different levels of managerial-shareholder misalignment. Following Nikolov and Whited (2014), we model managers’ contracts to include three clauses that could potentially induce such misalignment: limited managerial ownership, managerial perquisite and size-dependent bonus. Risk-averse

\(^1\)For example, Core, Holthausen, and Larcker (1999) find that firms with greater agency conflicts incur higher expenditure on executive compensation but perform worse; Bliss and Rosen (2001) document that executives benefit from merger and acquisitions even if those actions destroy firm value; Gompers, Ishii, and Metrick (2003) show that stock returns of firms with weaker shareholder rights (higher agency conflicts) is 8.5% lower than those of firms with stronger shareholder rights (lower agency conflicts) per annum.

\(^2\)See, e.g., Bliss and Rosen (2001) and Nikolov and Whited (2014), among others.
shareholders in our model value firm’s future cash flow using a time-varying stochastic discount factor (SDF). The dynamics of the SDF is driven by an aggregate shock that also affects firm’s productivity \cite{Berk, Green, and Naik 1999}. In equilibrium, cash policy of a firm crucially depends on firm fundamentals as well as managerial compensation structure. Among firms that are absence of agency issues (hereafter non-agency firms for short), firms with higher growth opportunities or cash flow uncertainty tend to hold more cash. Higher cash holding thus corresponds to higher future stock return. In firms with agency conflicts (hereafter agency firms for short), managers tend to over-invest due to misaligned incentives embedded in the compensation package. As a result, agency firms also hold more cash.

Two groups of firms exhibit distinct patterns of operating performance and subsequent stock returns. In the non-agency group, the precautionary motive for firm cash holding implies that firms with higher cash level have higher optimal level of capital and investment. Accordingly, those firms also have higher profitability. In agency firms, however, managers in fact invest beyond the optimal level for shareholders. Over-investment, decreasing returns to scale production technology and convex investment adjustment cost jointly hurt agency firms’ profitability and operating performance, which results in a negative cash-profitability relation. If shareholders are not aware of potential agency conflicts induced by the managerial compensation structure, they will incorrectly perceive high cash holding and over-investment observed in agency firms as a signal of high growth opportunity. The under-estimation of agency costs would cause over-estimating firms’ intrinsic values and low future stock returns.

Our model has direct implications that match many empirical results documented in the previous research. In our model, growth opportunities and cash flow uncertainty are the determinants of cash holdings in non-agency firms, which is consistent with the empirical evidence provided in \cite{Opler et al. 1999}. The precautionary motive further implies a positive cash-return relation for non-agency firms, same as reported in \cite{Palazzo 2012}. For agency firms, our model is able to generate the over-investment and value-destroying behavior endogenously, both of which are ubiquitous in the literature. For example, \cite{Harford 1999} suggests
that agency conflicts can explain the abnormal acquisition behavior and the post-acquisition value-decreasing pattern of cash-rich firms; Harford, Mansi, and Maxwell (2008) show that firms with weaker corporate governance structure (higher agency conflicts) have higher capital expenditure but lower profitability. Moreover, lower subsequent equity returns for firms with higher agency conflicts is also consistent with existing empirical evidence (Core, Holthausen, and Larcker 1999; Bliss and Rosen 2001; Gompers, Ishii, and Metrick 2003; Yermack 2006).

The key feature implied by our model that distinguishes agency firms from non-agency ones is their distinct investment-profitability relations. Motivated by this insight, we use the firm expense ratio (XR), which is measured as the ratio of firm’s selling, general and administrative (SG&A) expenses to its total operating income, to gauge a firm’s agency problem in the empirical analysis. A large portion of SG&A expenses covers the managerial compensation, perquisite and investment adjustment cost, hence this ratio measures the cost of investment in terms of per unit of gross profit. Economically, this measure captures the intuition of the side-cost that shareholders must pay before claiming the net income. High XR means inefficient cost control during the investment and profit generating process, suggesting the existence of agency conflicts.

We sort the cross section of stocks based on their industry-adjusted expense ratio (IXR) and categorize the stocks that fall in the top two deciles of the monthly IXR distribution as agency firms. In both agency and non-agency group, high cash firms have high Tobin’s q and capital expenditure. Meanwhile, current cash flows of high-cash firms are smaller, indicating that those firms are more likely to rely on external financing. However, as predicted by the model, two groups show opposite investment-profitability relation. In the non-agency group, high-cash firms generally have higher profitability and equity returns. Each month by further sorting all non-agency firms into ten deciles based on their cash holding, the equal (value) weighted return of firms in the highest cash decile outperform the returns of firms in the lowest cash decile by 0.37% (0.20%) per month, both of which are not able to be explained by the Fama and French (1993) and Fama and French (2015) model. In the agency group, both cash holding and investment increase with the IXR. At the same time, however, firms’
profitability and equity return decrease monotonically, which suggests investments made by agency firms are much less efficient. By further sorting all agency firms based on their IXR into five quintiles each month, the average returns on assets (ROA) in the quintile with the lowest (highest) IXR is 10.8% (-23.3%). Meanwhile, firms with the highest IXR have lowest stock returns. The average monthly portfolio return spread between the lowest and highest IXR quintiles is -0.84% (-1.15%) under equal (value) weighted scheme, which cannot be explained by other risk factors such as the market portfolio, size, value, investment and profitability.

Our paper contributes to the empirical corporate finance literature on providing a theoretical model that links agency conflicts, firm cash holding, firm operating performance and subsequent equity return. Our model is able to endogenously generate the patterns of over-investment, value-destroying and subsequent decline in firm equity returns for agency firms, all of which are well-documented in the previous research. Methodologically, our paper belongs to the investment-based asset pricing literature (Cochrane 1991 1996). Our paper relates with Gamba and Triantis (2008) and Riddick and Whited (2009), where the authors evaluate the value of cash from the precautionary saving perspective. However, shareholders in both papers are risk-neutral and more importantly, as argued by Nikolov and Whited (2014), ignoring potential agency conflicts in the model structure could result in serious issues of model misspecification. Using structural estimation, they show that shutting down agency channel in the model would result in an unrealistic high estimation of the cost on external financing. Livdan, Sapriza, and Zhang (2009) consider the stock returns of financially constrained firms. They show that the inflexibility of issuing new debts for financially constrained firms prevents those firms from dividend smoothing hence demands higher expected returns. Palazzo (2012) extends Livdan, Sapriza, and Zhang (2009) by linking firm financial decisions to the fundamentals. In his model, firms with higher cash flow uncertainty and more growth opportunities tend to hold more cash to financing the potential investment. Meanwhile, dividends of those firms have a higher correlation with the aggregate shock. As a result, he establishes a positive cash-return relation from a precautionary motive. However, he does not take into account the potential agency conflicts and the investment opportunity in his model is exogenous and
independent of firm’s productivity, which is far from reality. Nikolov and Whited (2014) is probably the paper that most closely related with ours in the literature. They consider the impact of different agency issues on firm’s cash holding policy using a structural estimation approach similar to Hennessy and Whited (2005, 2007) and DeAngelo, DeAngelo, and Whited (2011). Unlike our paper, they do not consider the stock return from a risk-averse shareholder’s perspective and the SMM-type estimation provides limited insight on an individual firm because of the substantial cross-sectional heterogeneity among firms and the difficulties in identifying latent parameters that govern the level of agency conflicts for a given firm. In contrast, we are able to directly measure the level of agency conflicts at the firm level and examine their cross-sectional implications, using a proxy that directly come from the model.

The rest of the paper is organized as follows. Section 2 develops and illustrates the mechanism of the model framework. Section 3 discusses the identification process of agency firms, along with other empirical analysis and section 4 concludes.

II. Model

We modify and extend the three-period model proposed in Kim, Mauer, and Sherman (1998) and Palazzo (2012) by allowing endogenous investment decision. In the model, the optimal cash holding of a non-agency firm increases with the firm’s growth opportunities and cash flow uncertainty. The dividend of high cash firms thus possesses stronger correlation with the aggregate shock. From shareholders’ perspective, investing in high cash non-agency firms are exposed to additional risks.

By modifying the managerial compensation structure, we introduce agency frictions via misaligned managerial-shareholder incentives. Due to this misalignment, a manager will always invest beyond the optimal level for a shareholder. Over-investment, decreasing returns to scale production technology, and the convex investment adjustment cost seriously impair the firm’s profitability and deteriorate its operating performance. If a shareholder is not aware of potential agency issues induced by the misaligned incentives, she obtain the ex-ante subjective firm value by simply substituting the observed firm cash and investment decision into her own
optimal policy function, which leads to an overestimation of firm’s present intrinsic value and a subsequent decline in its future equity return.

II.1. Basic Model.

In the following subsections, we introduce the model setup, production technology, SDF and managerial compensation structure in sequence, followed by the analysis of optimal cash/investment policy, objective/subjective firm intrinsic value and expected stock return.

II.1.1. Model Setup.

In this economy, there exists a continuum of infinitely-lived firms with a discrete time setting indexed by \( t = 0, 1, 2 \cdots \). All firms are endowed with the same initial cash \( C_0 \) and capital \( K_0 \) and make cash saving and investment decision once.

At the beginning of period \( t = 0 \), managers choose the amount of cash \( C_1 \) to hold in the next period. Cash held by firms is subject to corporate taxes thus the internal gross rate \( \hat{R} \) is less than the risk free rate \( R_f \) that a shareholder can earn from outside (Riddick and Whited, 2009; Palazzo, 2012). Managers make investment decisions at the beginning of period \( t = 1 \). If the investment can be fully funded internally through the cash stock \( C_1 \) and current profit \( X_1 \) generated during period 0, the remaining liquidity would be distributed to shareholders as dividend. If otherwise (denoted as \( \Phi_e \)), an extra flotation cost \( \lambda \) is needed for each dollar raised externally.

Starting from period \( t = 2 \), we assume firms keep their physical capital staying at the same level, i.e., \( K_t \equiv K_2 \), for \( t \geq 2 \) and no longer hold cash. This setting indicates that the investment are made passively in period \( t \geq 2 \), just to cover the capital depreciation and adjustment cost.\(^3\)

\(^3\)Accordingly, there would be no flotation cost if external financing is needed in the case that the current profit is not enough to cover the passive investment, which is rarely the case in the simulation.
II.1.2. Production Technology.

Firms only use physical capital $K$ in their production and are subject to firm-specific productivity shock $\varepsilon_x$. For each period $t$, firm $x$’s current profit is given by the production function

$$X_t = e^{\varepsilon_{x,t}} K_t^\theta,$$

where the production technology exhibits decreasing returns to scale with $0 < \theta < 1$.

The productivity shock $\varepsilon_{x,t+1}$ follows a stationary $AR(1)$ process

$$\varepsilon_{x,t+1} = \rho_x \varepsilon_{x,t} + \sigma_x v_{x,t+1}, \quad v_{x,t+1} \sim N(0, 1).$$

We assume that all firms share the same non-zero first order correlation coefficient $\rho_x$ but the conditional volatility $\sigma_x$ are firm specific. We further assume that $\varepsilon_{x,0}$ takes the value of its unconditional mean 0 and same across all firms.

Firm investment $I_t$ is defined as

$$I_t = K_{t+1} - (1 - \delta)K_t,$$

where $\delta \in (0, 1)$ is the constant capital depreciation rate. A positive $I_{t+1}$ means that the firm decides to invest while a negative $I_{t+1}$ corresponds to dismantling equipments and disinvestment. Once investment or disinvestment happens, the firm incurs additional adjustment costs $\Psi(I_t)$. The functional form of $\Psi$ is symmetric and quadratic:

$$\Psi(I_t) = \frac{a}{2} \left( \frac{I_t}{K_t} \right)^2 K_t,$$

where $a$ is a positive constant.\footnote{For simplicity, we do not consider the case of costly reversibility in investment, as in Kogan (2001), Zhang (2005) and Lin and Zhang (2013).}

II.1.3. SDF.

Following Zhang (2005), the dynamics of a shareholder’s SDF $M_{t+1}$ is affected by an aggregate
shock $\varepsilon_{m,t+1}$ via

$$\log M_{t+1} = \log \beta_m + \gamma (\varepsilon_{m,t} - \varepsilon_{m,t+1}),$$

(5)

where $\beta_m$ is the constant parameter of impatience and $\gamma$ is the price of risk which is also assumed to be constant. The aggregate shock $\varepsilon_{m,t+1}$ follows an AR(1) process

$$\varepsilon_{m,t+1} = (1 - \rho_m)\bar{\varepsilon}_m + \rho_m \varepsilon_{m,t} + \sigma_m v_{m,t+1}, \quad v_{m,t+1} \sim \mathcal{N}(0, 1).$$

(6)

Firm level productivity shock $\varepsilon_{x,t+1}$ is conditionally correlated with the aggregate shock $\varepsilon_{m,t+1}$ shock in Eq.(5), i.e.,

$$\text{Cov}_t (\varepsilon_{x,t+1}, \varepsilon_{m,t+1}) = \sigma_x \sigma_m \text{Cov}_t (v_{x,t+1}, v_{m,t+1}) = \rho_{xm} \sigma_x \sigma_m.$$  

(7)

II.1.4. Compensation Structure.

Following Nikolov and Whited (2014), we consider three types of incentives that could result in misaligned managerial-shareholder interests: limited managerial ownership, size-dependent bonus and managerial perquisite. In our model, the manager owns a $\beta$ fraction of total outstanding equity. Meanwhile, she receives $\alpha$ portion of the firm’s current profit, which mimics a size-dependent bonus. Moreover, she also consumes $s$ portion of the firm’s internal funds as perquisite. Combinations of managerial ownership $\beta$, the profit-sharing parameter $\alpha$ and the tunneling parameter $s$ thus describe the level of misaligned managerial-shareholder interest in a firm, as a manager is maximizing her total discounted cash flow. Agency frictions increase with $\alpha$ and $s$, and decrease with $\beta$.

II.1.5. Optimal Policies.

A. Cash Flow.

We use $d_t$ to denote the cash flow that is distributed to shareholders. At time $t = 0$, the manager consumes $sC_0$ as personal perquisite, retains the amount $\frac{C_0}{R}$ from the initial cash endowment and distribute the rest to shareholders. At time $t = 1$, a manager makes investment decision after observing the realization of productivity shock $\varepsilon_{x,1}$. A firm uses its internal funds
to finance the investment before turning to costly external financing. A firm’s internal funds consist of its cash stock $C_1$ and current profit $X_1$ that is given by Eq. (1). After taking into account manager’s perquisite and profit sharing, firm’s financing gap is given by the following accounting identity

$$d_1^* = (1 - s) C_1 + (1 - \alpha - s) X_1 - I_1 - \Psi (I_1). \tag{8}$$

A positive $d_1^*$ means positive cash distribution to shareholders while $d_1^* < 0$ means equity issuance or external financing. After period 1, a firm no longer hold cash and all investment are passively made by simply covering the depreciation and adjustment cost, i.e.,

$$I_t = \delta K_1, \quad \text{for } t \geq 2. \tag{9}$$

In sum, total cash flow received by shareholders can be written as

$$d_0 = (1 - s) C_0 - \frac{C_1}{R}, \tag{10}$$

$$d_1 = (1 + \lambda \Phi_e) [(1 - s) C_1 + (1 - \alpha - s) X_1 - I_1 - \Psi (I_1)], \tag{11}$$

$$d_t = (1 - \alpha - s) X_t - I_t - \Psi(I_t), \quad \text{for } t \geq 2. \tag{12}$$

### B. The Objective Function.

Managers and shareholders are risk-averse and their utility are linear in the total cash flow they received. Let $u_t$ denote the total compensation received by a manager, we have

$$u_t = (\alpha + s) X_t + sC_t + \beta d_t. \tag{13}$$

Substituting $d_t$ in Eq. (13) using Eq. (10)-(12), the total cash flow received by a manager can be written as

$$u_0 = sC_0 + \beta d_0, \tag{14}$$

$$u_1 = (\alpha + s) X_1 + sC_1 + \beta d_1, \tag{15}$$
\[ u_t = (\alpha + s)X_t + \beta d_t, \quad \text{for } t \geq 2. \quad (16) \]

Hence a manager chooses period 1 investment \( I_1 \) and a non-negative cash holding \( C_1 \) to maximize her utility:

\[ U_0 = \max_{C_1 \geq 0, I_1} \{ u_0 + E_0 [M_1 (u_1 + E_1 [M_2 U_2])] \}, \quad (17) \]

where \( U_2 \) is obtained using an iterated Bellman equation:

\[ U_t = \max \{ u_t + E_t [M_{t+1} U_{t+1}] \}. \quad (18) \]

Shareholders are facing a different utility maximization problem because generally \( \beta d_t \neq u_t \).

Specifically, the optimal cash holding \( \tilde{C}_1 \) and investment \( \tilde{I}_1 \) from a shareholder’s perspective is to maximize

\[ V_0 = \max_{\tilde{C}_1 \geq 0, \tilde{I}_1} \{ d_0 + E_0 [M_1 (d_1 + E_1 [M_2 V_2])] \}, \quad (19) \]

where \( V_2 \) is obtained similarly

\[ V_t = \max \{ d_t + E_t [M_{t+1} V_{t+1}] \}. \quad (20) \]

C. Optimal Cash Policy.

Differentiating Eq.\((17)\) with respect to \( C_1 \), the marginal cost (MC) and the marginal benefit (MB) of cash holding from a manager’s perspective can be written as

\[ MC_{C_1} = \frac{\beta}{\hat{R}}, \quad (21) \]

\[ MB_{C_1} = E_0 [M_1 [s + \beta (1 - s) (1 + \lambda \Phi_e)]]. \quad (22) \]

Eq.\((21)\) says that for a manager, the period 0 cost of one dollar cash in period 1 is simply her equity stake \( \beta \) times what it is worth today \((1/\hat{R})\). Eq.\((22)\) describes the period 0 value of the

\(^5\)Shareholders and managers share the same maximization problem if their objective functions differentiate with a constant parameter.
benefits that one dollar cash can bring in period 1, which consists of two parts. Managerial compensation contract ensures the manager can consume $s$ as perquisite. For the rest $(1-s)$, it is worth $\beta(1+\lambda)(1-s)$ when $d_1^*$ is negative (financing) or $\beta(1-s)$ when $d_1^*$ is positive (distribution). All cash flows are discounted back to period 0 using the manager’s SDF $M_1$ for direct comparison.

From a shareholder’s perspective, the optimal cash holding $\bar{C}_1$ is determined by the first order condition of Eq.(19). To investigate the effect of agency frictions on firm’s optimal cash holding, we consider a hypothetical shareholder who also holds $\beta$ portion of the firm’s total equity. For this shareholder, $\$1$ of extra cash in period 1 has the following marginal effects:

\[
MC_{\bar{C}_1} = \frac{\beta}{R}, \tag{23}
\]
\[
MB_{\bar{C}_1} = \beta(1-s)E_0[M_1(1+\lambda\Phi_{e})]. \tag{24}
\]

Comparing Eq.(21) and (22) with Eq.(23) and (24), we find that for any level of cash holding, MC of cash is the same for the manager and the shareholder. However, the manager’s MB of cash exceeds that for the shareholder by $E_0(M_1s)$. Observing that both Eq.(22) and Eq.(24) decrease with respect to firm cash holding, $MB_{C_1} > MB_{\bar{C}_1}$ thus implies that $C_1 > \bar{C}_1$.

Assuming an interior solution, we plot the optimal cash holding for both the manager and the shareholder in the left panel of Figure 1. The flat thin solid line represents the MC curve of cash for both the manager and the shareholder, while the thick solid line and dashed line represent the MB curves for the manager and the shareholder, respectively. Both MB curves are decreasing in firm cash holding in period 0, suggesting that the more a firm saves in period 0, the smaller probability it needs external financing in period 1 and thus a smaller expected reduction in equity issuance cost. We also find that agency frictions cause a manager to hold more cash, as the optimal cash for the manager ($C_1$, the blue dot) is always greater than that for the shareholder ($\bar{C}_1$, the red dot).

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6The probability of external financing $\Phi_e$ in period 1 decreases with the level of cash holding in period 0.
We use $\Delta C_1 \equiv C_1 - \tilde{C}_1$ to denote the distortion in optimal cash policy due to agency conflicts. Under quite general assumptions, we can show that the cash distortion $\Delta C_1$ increases with agency frictions:

**Theorem II.1.** The distortion in optimal cash policy $\Delta C_1$ increases with $s$ if $\beta (1 + \lambda) < 1$ and $0 < \beta < 1$; it is a non-decreasing function of $\alpha$ if $0 < \beta < 1$. Moreover, $\Delta C_1$ decreases with $\beta$ if $s > 0$, i.e.,

$$\frac{\partial \Delta C_1}{\partial s} > 0, \text{ if } \beta (1 + \lambda) < 1, \ 0 < \beta < 1,$$

$$\frac{\partial \Delta C_1}{\partial \alpha} \geq 0, \text{ if } 0 < \beta < 1,$$

$$\frac{\partial \Delta C_1}{\partial \beta} < 0, \text{ if } s > 0.$$

If a firm is absence of agency frictions, the manager will choose the level of cash holding equal to $\tilde{C}_1$, as it is to the best interest of shareholders. Under this circumstance, we can show that firm’s optimal cash holding increases with the precautionary saving motive.

**D. Optimal Investment Policy.**

The MC and MB of extra unit of investment in period 1 for the manager and the shareholder can be obtained by differentiating each party’s objective function with respect to the investment. From Eq. (17), the MC and MB of investment for the manager are:

$$MC_{I_1} = \beta (1 + \lambda \Phi_e) \left( 1 + a \frac{I_1}{K_1} \right),$$

$$MB_{I_1} = [\alpha + s + \beta (1 - \alpha - s)] E_1 \left[ M_2 \cdot \Sigma_{mx,2} \left( \theta K_2^{g-1} \right) \right] - \beta \delta (1 + \frac{a}{2} \cdot \delta) E_1 \left[ M_2 \cdot \Sigma_{m,2} \right],$$

where both $\Sigma_{mx,2}$ and $\Sigma_{m,2}$ can be evaluated using the iterated relation

$$\Sigma_{mx,t} = e^{\xi_{x,t}} + E_{t} \left[ M_{t+1} \Sigma_{mx,t+1} \right],$$

$$\Sigma_{m,t} = 1 + E_{t} \left[ M_{t+1} \Sigma_{m,t+1} \right].$$
Therefore, $\Sigma_{mx,2}$ can be considered as an effective productivity shock and $\Sigma_{m,2}$ is the price of a perpetual risk-free bond because of the passive investment setting for $t \geq 2$.

Eq.(25) shows that from the manager’s perspective, the MC of $\$1$ investment in period 1 is the product of her equity stake $\beta$, additional flotation cost $\lambda$ when external financing $\Phi_e$ is needed and $\$1$ investment along with the adjustment cost $a\frac{1}{K_1}$. The MC function increases with the period 1 investment $I_1$, due to the existence of the convex adjustment cost $\Psi(I_1)$.

The MB for the manager consists of two parts. The first term in Eq.(26) corresponds to the effective increment in total output in period 2, which is equal to the expected discounted marginal productivity of capital $E_1 \left[M_2 \Sigma_{mx,2} \cdot \theta K_2^{\theta-1}\right]$. The term $\alpha + s + \beta(1 - \alpha - s)$ reflects the stake that the manager can claim. The second term in Eq.(26) represents the expected discounted passive investment and the adjustment cost for all future periods.

Similarly, the marginal effects for the hypothetical shareholder are given as follows:

$$MC_{\tilde{I}_1} = \beta (1 + \lambda \Phi_e) \left(1 + \frac{a}{K_1} I_1\right),$$

$$MB_{\tilde{I}_1} = \beta (1 - \alpha - s) E_1 \left[M_2 \cdot \Sigma_{mx,2} \left(\theta K_2^{\theta-1}\right)\right] - \beta \delta (1 + \frac{a}{2} \cdot \delta) E_1 \left[M_2 \cdot \Sigma_{m,2}\right].$$

Eq.(26) and (30) show that at any given level of investment, the manager is strictly better off than the shareholder by the amount of $(\alpha + s)E_1 \left[M_2 \cdot \Sigma_{mx,2} \theta K_2^{\theta-1}\right]$. Following a similar monotonicity argument, we can also show that manager’s optimal investment $I_1$ is always greater than that for the shareholder.

Under the assumption of interior solution, we plot the optimal investment for both the manager and the shareholder in the right panel of Figure 1. The upward thin solid line represents the MC curve of cash for both the manager and the shareholder, while the thick solid line and dashed line represent the MB curves for the manager and the shareholder, respectively. Both MB curves are decreasing with firm investment in period 1, because of the decreasing returns to scale production technology Eq.(1). We also find that agency frictions cause a manager to over-invest, as the optimal investment for the manager ($I_1$, the blue dot) is always greater than that for the shareholder ($\tilde{I}_1$, the red dot).
Moreover, defining the distortion in optimal investment policy in a similar manner, i.e., $\Delta I_1 \equiv I_1 - \widetilde{I}_1$, we can also show that $\Delta I_1$ always increases with agency frictions.

**Theorem II.2.** The distortion in optimal investment policy $\Delta I_1$ increases with $\alpha$ and $s$ if $0 < \beta < 1$. Moreover, $\Delta I_1$ decreases with $\beta$ if $\alpha$ and $s$ are non-negative and not simultaneously 0, i.e.,

$$
\frac{\partial \Delta I_1}{\partial \alpha} > 0, \quad \frac{\partial \Delta I_1}{\partial s} > 0, \quad \text{if} \quad 0 < \beta < 1,
$$

$$
\frac{\partial \Delta I_1}{\partial \beta} < 0, \quad \text{if} \quad \alpha \geq 0, \ s \geq 0, \ \alpha + s \neq 0.
$$

In a non-agency firm, the manager will choose the level of investment equal to $\widetilde{I}_1$, following a similar argument. We can also show that $\widetilde{I}_1$ increases with the firm’s demand of precautionary saving.

**E. Profitability.**

Under the one-time investment decision setting, we define a firm’s profitability at period $t = 1$ as the ratio of its total discounted future profits and total discounted capital, i.e.,

$$
\pi = \frac{\sum_{t=2}^{\infty} E_1[M_{1,t}X_{t+1}]}{\sum_{t=2}^{\infty} E_1[M_{1,t}K_{t+1}]}.
$$

(31)

where $M_{1,t} \equiv \prod_{i=2}^{t} M_i$ is the t-period SDF.

Use $\pi_1$ and $\widetilde{\pi}_1$ to denote firm’s profitability under manager $(C_1, I_1)$ and shareholders’ $(C_1, \widetilde{I}_1)$ optimal policies, respectively. We have the following theorem

**Theorem II.3.** The profitability $\pi_1$ is a decreasing function with respect to $\alpha$ and $s$ if $0 < \beta < 1$; it is an increasing function with respect to $\beta$ if $\alpha$ and $s$ are non-negative and not simultaneously 0. The profitability $\widetilde{\pi}_1$ increases with firm fundamental $\sigma_x$ if $\sigma_x > \max \left[ \frac{1-\rho_x^2}{1-\rho_m \rho_x}, 1 \right]$. Moreover, $\pi_1$ is always smaller than $\widetilde{\pi}_1$ when $0 < \beta < 1$ and $\alpha$ and $s$ are not simultaneously 0, i.e.,

$$
\frac{\partial \pi}{\partial \alpha} < 0, \quad \frac{\partial \pi}{\partial s} < 0, \quad \text{if} \quad 0 < \beta < 1,
$$
\[
\frac{\partial \pi}{\partial \beta} > 0, \text{ if } \alpha \geq 0, \ s \geq 0 \text{ and } \alpha + s \neq 0, \\
\frac{\partial \bar{\pi}}{\partial \sigma_x} > 0, \text{ if } \frac{\sigma_x}{\gamma \rho \sigma m} > \max \left[ \frac{1 - \rho_x^2}{1 - \rho_m^2}, 1 \right], \\
\pi < \bar{\pi}, \text{ if } \alpha \geq 0, \ s \geq 0, \ \alpha + s \neq 0 \text{ and } 0 < \beta < 1.
\]

Theorem II.3 show that probability is a key feature to distinguish non-agency firms from the agency ones. Over-investment beyond the optimal level hurts firms’ profitability while fundamental-driven investment is accompanied with high profitability.

F. Agency Costs.

As managers have strong incentives to hide misbehavior, shareholders may not be aware of potential agency issues, i.e., shareholders think all firm decisions are made in the best of their interest. The empirical evidence in Gompers, Ishii, and Metrick (2003) shows that shareholders will overstate a firm’s intrinsic value, operating performance and stock return if they underestimate potential agency costs. In this subsection, we provide a detailed quantitative analysis on the agency costs in our model.

Following previous theorems and propositions, the ignorance of agency issues directly misleads shareholders’ perception of the observed firm cash and investment decisions by incorrectly interpreting cash-hoarding and over-investment as strong firm fundamental. To better illustrate this point, we plot firms’ optimal cash and investment policies for both manager and shareholders at different firm fundamental parameter \(\sigma_x\) in Figure 2. To investigate the marginal effect of \(\sigma_x\) on each misalignment parameter, we let one of friction parameters be non-zero and shut down the other frictions.

\[\text{[Insert Figure 2 about here]}\]

In the left column we plot the optimal policies when only the profit-sharing parameter \(\alpha\) is non-zero, while in the right column we present the effect of non-zero tunneling parameter \(s\). In the basic model, the conditional volatility of firm-specific productivity shock \(\sigma_x\) determines both cash flow uncertainty and firm growth opportunity.
both columns, the tendency of cash-hording and over-investment for a manager implies that managers always overstate firm’s growth opportunity. Consider, for example, the observed firm cash decision is equal to 0.25. By plotting a horizontal dashed line at 0.25, true $\sigma_x$ in Eq. (2) is determined by the intersection of the dashed horizontal line and manager’s policy function (blue dot). However, when ignoring the potential agency costs, a shareholder subjectively overestimate $\sigma_x$ at $\sigma_x^S$ (red dot). This is true for both $\alpha$ and $s$. A similar argument follows when the shareholder observe the firm’s investment decision. Therefore, shareholders will overstate firm’s fundamental if she fails to realize potential agency issues.

Overestimating firms’ fundamental will result in overstating firms’ intrinsic values. Given agency friction parameters $\alpha$, $s$ and $\beta$, the lower bound of the overestimation can be computed using the following theorem.

**Theorem II.4.** When there exists agency issues, shareholders overestimate the discounted future cash flow by $1 + \frac{\alpha + s}{\beta (1 - \alpha - s)}$, which results in an overestimation of firm value by at least the same amount, i.e.,

$$
\frac{E^S_1 [M_2 \cdot \Sigma_{mx,2}]}{E_1 [M_2 \cdot \Sigma_{mx,2}]} = 1 + \frac{\alpha + s}{\beta (1 - \alpha - s)},
$$

$$
\frac{E^S_1 [M_2 V_2]}{E_1 [M_2 V_2]} \geq 1 + \frac{\alpha + s}{\beta (1 - \alpha - s)}, \text{ if } 0 < \beta < 1,
$$

where the notation $E^S [\cdot]$ denotes the subjective expectation for shareholders.

According to Theorem II.4, higher tunneling parameter $s$ or profit sharing parameter $\alpha$ and lower managerial equity share $\beta$ result in higher agency costs, and thus larger estimation bias in firm’s intrinsic value. Lower subsequent equity return naturally follows the overestimation of a firm’s intrinsic value. To see this point, we define a firm’s expected equity return between period $t = 1$ and 2 as the ratio of its conditional objective expected discounted future dividends over current price that is calculated from the subjective intrinsic firm value:

$$
E_1 [R_{1,2}] = \frac{E_1 [d_2 + \sum_{t=3}^{\infty} M_{2,t} d_t]}{P_1} = \frac{E_1 [V_2]}{E^S_1 [M_2 V_2]},
$$

(32)
In Figure 3 we plot how firm fundamental $\sigma$ and misalignment parameters $\alpha$, $s$ and $\beta$ affect firm values and expected equity returns. In the upper row we present both firm’s objective value taking into account potential agency costs ($V^O$) and subjective value ignoring such cost ($V^S$) while the bottom row present the expected equity return $E_1[R_{1,2}]$ when shareholders fail to include agency costs in the valuation. In each plot, we change one parameter while keep the rest three equal to the benchmark, which generally follow Zhang (2005), Lin (2012) and Nikolov and Whited (2014), which is presented in Table 1. As shown in the figure, underestimating agency costs would result in an overestimation of firms’ intrinsic values and lower subsequent return $E_1[R_{1,2}]$.

The following theorem shows that ignoring agency costs would also result in overestimating firms’ Tobin’s Q.

**Theorem II.5.** When there exist agency issues, firm’s true Tobin’s Q decreases with $\alpha$ and $s$. However, shareholder’s subjective Tobin’s $Q^S$ increases with $\alpha$ and $s$.

$$\frac{\partial Q^S}{\partial \alpha}, \frac{\partial Q^S}{\partial s} > 0, \text{ if } 0 < \beta < 1,$$

$$\frac{\partial Q}{\partial \alpha}, \frac{\partial Q}{\partial s} < 0, \text{ if } 0 < \beta < 1.$$

**III. Empirical Analysis**

**III.1. Measuring Agency Conflicts.**

The model in the previous section confirms several empirical patterns documented in the literature. Managers with agency issues tend to over-invest because of the misaligned managerial incentives. High capital depreciation and convex investment adjustment cost hurt firm’s profitability and distributable cash flow. However when referring to the empirical analysis, it is hard to directly pin down model parameters $\alpha$, $\beta$ and $s$ at the firm level since all of them are
Moreover, due to different cash sensitivity with respect to each of them, identification from the cash side is also difficult to implement.

From the perspective of shareholders, the agency friction should be measured as the losses in firm distributable cash flow, comparing to the scenario that no such friction is presence. Motivating by this insight, we propose a novel measure of agency conflicts at the firm level, namely, the expense ratio ($XR$), which is measured as the percentage of SG&A expenses in total operating income. The reasoning are as follows. First, according to the U.S. GAAP, SG&A expenses cover all commercial expenses of operation incurred to support (but not directly related to) production and manufacturing. Hence potential managerial perquisite should be reported under this item. Second, managerial compensation, including wages and all cash bonus and equity/option compensation, are included in SG&A expenses. And more importantly, a large part of SG&A expenses relates to facility cost and training of labor, which fits the definition of investment adjustment cost in our model.

High SG&A expenses alone (or scaled by firm’s total asset) does not necessarily mean higher agency conflicts. In fact, in accounting literature (see, e.g., Lev and Radhakrishnan (2005)), people use SG&A expenses to measure firm’s organization capital. Eisfeldt and Papanikolaou (2013) propose a dynamic model in which the organization capital of a firm is more riskier than its physical capital from shareholders’ perspective. Using the SG&A expenses as the inflow of organization capital, they empirically show that firms with higher ratio of organization capital to book value of total asset ($O/K$ ratio) have higher expected returns.

We scale of SG&A expenses by firm’s operating income, which is defined as the difference between total sales and costs that directly related to production process. As operating income matches the current profit term in our model, SG&A expenses capture the investment adjustment cost that the incurred by the firm, which plays an important role in determining the final distributable cash flow to shareholders. One can also understand the measure via

\[^8\]Previous literature tries to backup some parameters from other data source. For example, Nikolov and Whited (2014) uses the shares and options awarded to managers from the Execucomp to compute the effective managerial ownership and proxies it as $\beta$. This exercise should be considered as a subsample analysis at best. More importantly, manager-owned options have the incentive similar to a market-cap dependent bonus, in which both $\alpha$ and $\beta$ effects exist and cannot be distinguished.
The following

\[ XR = \frac{XSGA}{OI} = \frac{XSGA/AT}{OI/AT}. \]

The numerator is hence the inflow of organization capital proposed in Eisfeldt and Papanikolaou (2013) and the denominator is gross profitability in Novy-Marx (2013). The measure hence has a novel economic meaning: a higher expense ratio means a firm over invests in projects lack of profitability. In oppose to the definition of organization capital in Eisfeldt and Papanikolaou (2013), such low-profitability investment will not generate extra cash flow, which suggests potential agency conflicts.

III.2. Data.

Monthly stock returns are obtained from the Center for Research in Security Prices (CRSP) and firm accounting data are from Compustat Annual. We include the common shares of all firms traded on NYSE, Amex and Nasdaq. All returns are adjusted for delisting. If a delisting return is missing for performance-related reason, we impute a return of -30% for NYSE/Amex stocks and -55% for Nasdaq stocks (Shumway 1997; Shumway and Warther 1999). We assume annual accounting information from Compustat is available six months after the reporting date. The sample consists of firms that have non-missing revenue, SIC code and Fama and French (1997) 48-industry classification. We also restrict our sample to firms with positive total assets, book value of equity, cash-to-asset and expense ratio. Following Nikolov and Whited (2014), we exclude firms from financial (SIC 6000-6999) and utility (SIC 4000-4999) sectors from our sample, as both sectors are highly regulated. To correct for the survivorship bias of Compustat data, we exclude the first two-year’s observations for each firm. Our sample starts from July 1970 and ends in December 2016.

Ball et al. (2015) report that the Standard & Poor’s adjusts the SG&A expenses in Compustat database by summing the SG&A expenses filed by the firm and the research & development (R&D) expenses. As firm R&D expenses do not quite fit the definition of investment adjustment cost in our model, we reconstruct firm’s original SG&A expenses by subtracting the reported R&D expenses. We measure firm size as the natural logarithm of the market value of
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firm equity. A firm’s book-to-market ratio is calculated using its market value of equity and book value of equity. The book value of equity is calculated as shareholders’ equity, plus balance sheet deferred taxes and investment tax credits (item TXDITC, if available), plus post retirement benefit liabilities (item PRBA, if available), minus preferred stock. We use the pecking order of redemption value, liquidation value or carrying value to calculate the book value of preferred stock. If shareholders’ equity is not available, we compute it as common equity (item CEQ) plus the carrying value of preferred stock (item PSTK). If the common equity is also missing, then we subtract total liabilities (item LT) and minority interest (item MIB) from the total assets (item AT).

We follow Nikolov and Whited (2014), Eisfeldt and Papanikolaou (2013), and Belo, Lin, and Bazdresch (2014) to define other firm investment related and financial characteristics, namely the Tobin’s Q, cash-to-assets ratio (CHR), cash flow (CF), investment (IK), external financing (EF), distribution (DISB), and return on assets (ROA). The details of variable construction are given in the appendix.

III.3. Portfolio analysis.

At the beginning of each month, we first adjust lagged firm level XR by its industry classification using a cross-sectional regression of XR on the Fama and French (1997) 48-industry dummy variable. We then sort all the non-financial and non-utility firms into decile portfolios based on their industry adjusted XR (IXR). Table 2 reports the time series average of characteristics of each decile portfolio. As the firm’s IXR increases, the average firm cash-to-asset ratio first decreases and then increases in the last two deciles. Tobin’s q, firm investment rate and external financing also exhibit a u-shaped trend. However, if we scrutinize on firm profitability, it shows that the return on assets decreases monotonically with the IXR. The results show that in the smallest 8 IXR deciles, firms in general has less severe agency problem. Firms with higher Tobin’s q invest more, which also corresponds to higher profitability. However, when we look at the largest two deciles, those firms’ investments suddenly increase along with higher Tobin’s q. However, the profitability of those firms deteriorates significantly and their
cash-to-asset ratio jumps up. According to our model, those firms have higher agency problem and hence their managers, based on their own utility maximization, choose to over-invest, hoard more cash and lead to lower profitability.

We then sort firms in the smallest 8 IXR deciles into 10 groups using cash-to-asset ratio. If our model is correct, then the main motive for holding cash among those firms is precautionary saving. Hence, cash holding should be proportional to firm’s investment and profitability. In Table 2, we show exactly the supportive evidence. We find that the average cash-to-asset ratio increases from 0.7% in the first decile to 48% in the last decile. Meanwhile, the average Tobin’s q increases by more than 100% from 1.11 to 2.37. Accordingly, firms investment increases by about 50%, from 12.4% to 17.5%. The profitability measure suggests that firms in this group are investing in projects that can generate value for the shareholders, indicating the precautionary motive can explain our finding. Moreover, the firm cash flow provides extra evidence. The average internal cash flow in the 10th decile is 0.7% less than the 1st decile and they are more likely to raise fund externally (with an average $EF$ of 8.6% in the 10th decile vs. 3.6% in the 1st decile). Both characteristics explain why the firms in this decile hold substantially more cash.

We further sort firms in the largest 2 IXR deciles into 5 quintiles based on their IXR and present the time-series average of portfolio characteristics in Table 3. Here we find quit different patterns as compared to the findings in the previous table. In this subsample, firms with higher IXR tend to hoard more cash. The average cash-to-asset ratio increases from 11.6% in quintile 1 to 26.0% in quintile 5, and the firm investment rate increases with the cash ratio, along with their Tobin’s q. However, in the highest IXR quintile, we find that profitability is the lowest, around -23.5%. The result suggests that managers of those firms
tend to severely over-invest. The high Tobin’s q within this group is more likely due to investors’ underestimating the agency frictions in those firms and overestimating the firm’s market value, as indicated in our model.

We examine the future stock returns for each sorted stock portfolios and present the results in Table 5. As expected, the returns in Panel A show an inverted U-shape. The portfolio excess return increases at the beginning with the firm IXR, from a 0.79% (0.57%) to 1.06% (0.79%) per month under equal- (value-) weighted scheme. It then slightly decreases from the 5th smallest IXR portfolio and collapses in the largest two deciles. In the largest IXR portfolio, we find that it generally earns negative excess returns, which remains significant under the CAPM, Fama and French (1993) three-factor model and Fama and French (2015) five-factor models. In Panel B, we find a positive cash-return relation among normal firms. The excess return is significant under equal weighted scheme, and factor adjusted abnormal returns are statistically significant under both weighting schemes. In Panel C, we examine the performance of agency firms. Same as our model predicts, the return spread between high and low agency firms is generally negative and significant in both schemes. The risk factor adjusted alphas remains significant.

IV. Conclusion

In this paper we study the relation between firm cash policy and stock return when there exists agency conflicts using a structural model. Our model can endogenously generate patterns that match the empirical findings documented in the literature: our model predict that firms with more agency conflicts tend to hold more cash and invest more. Meanwhile, they have lower profitability and perform worse. The subsequent low return associated with those firms is because shareholders underestimate such friction. Empirically, we find evidence that
support our model. We find positive cash-return relation among normal firms and the precautionary motive creates a return spread of 0.37% per month and significant after controlling for standard risk factors. In the agency group, long firms with low agency frictions and short firms with high agency frictions can generate a monthly excess return of 0.84%-1.15%. Our results show the important role that agency conflicts play in cross section stock returns, which points an interesting direction for future research.

APPENDIX: PROOF OF THEOREMS

The following lemmas are useful in proving the propositions and theorems.

**Lemma 1.** Assume two random variables $x_t$ and $z_t$ follow AR(1) processes,

$$
x_{t+1} = \rho_x x_t + \sigma_x u_{t+1},
$$

$$
z_{t+1} = \rho_z z_t + \sigma_z v_{t+1}.
$$

The innovations $u_{t+1}$ and $v_{t+1}$ follow a bivariate normal distribution with unit variances and a correlation of $\rho_{xz}$. Conditional mean and variance of linear combinations of $x_{t+k}$ and $z_{t+k}$ ($k$ is a positive integer) are given by

$$
E_t [ax_{t+k} + bz_{t+k}] = a \rho_x^k x_t + b \rho_z^k z_t,
$$

$$
Var_t [ax_{t+k} + bz_{t+k}] = a^2 \sigma_x^2 \left( \frac{1 - \rho_x^{2k}}{1 - \rho_x^2} \right) + b^2 \sigma_z^2 \left( \frac{1 - \rho_z^{2k}}{1 - \rho_z^2} \right) + 2ab \rho_{xz}\sigma_x\sigma_z \left( \frac{1 - \rho_x^k \rho_z^k}{1 - \rho_x \rho_z} \right)
$$

(34)

**Proof.** At time $t$, we have

$$
x_{t+k} = \rho_x^k x_t + \sigma_x \sum_{i=1}^{k} \rho_x^{k-i} u_{t+i},
$$

(35)

$$
z_{t+k} = \rho_z^k z_t + \sigma_z \sum_{i=1}^{k} \rho_z^{k-i} v_{t+i}.
$$

(36)
\[
E_t[ax_{t+k} + bz_{t+k}] = \alpha \rho_x^k x_t + b \rho_z^k z_t, \quad (37)
\]
\[
\text{Var}_t[ax_{t+k} + bz_{t+k}] = \sigma^2_x \sum_{i=1}^{k} \rho_x^{2(i-1)} = \sigma^2_x \left( \frac{1 - \rho_x^{2k}}{1 - \rho_x^2} \right), \quad (39)
\]
\[
\text{Var}_t[z_{t+k}] = \sigma^2_z \sum_{i=1}^{k} \rho_z^{2(i-1)} = \sigma^2_z \left( \frac{1 - \rho_z^{2k}}{1 - \rho_z^2} \right), \quad (40)
\]
\[
\text{Cov}_t[x_{t+k}, z_{t+k}] = \rho_{xz} \sigma_x \sigma_z \sum_{i=1}^{k} (\rho_x \rho_z)^{(i-1)} = \rho_{xz} \sigma_x \sigma_z \left( \frac{1 - \rho_x^k \rho_z^k}{1 - \rho_x \rho_z} \right). \quad (41)
\]
\[
\frac{\partial I_1}{\partial \beta} < 0, \text{ if } \alpha \geq 0, s \geq 0 \text{ and } \alpha + s \neq 0.
\]

**Proof.** Define the SDF \( M_{t,t+k} \) as the following form:

\[
M_{t,t+k} = M_{t+1} M_{t+2} \cdots M_{t+k} = \beta_k e^{\gamma (\varepsilon_{m,t} - \varepsilon_{m,t+k})}.
\]  

(42)

The firm’s ex-dividend value at time \( t = 1 \) is given by

\[
E_1 [M_2 V_2] = \sum_{t=2}^{\infty} E_1 [M_{1,t} d_t]
\]

\[
= (1 - \alpha - s) K_2^\delta E_1 [M_2 \cdot \Sigma_{m,x,2}] - \delta (1 + \frac{a}{2} \cdot \delta) K_2 E_1 [M_2 \cdot \Sigma_{m,2}],
\]  

(43)

where \( \Sigma_{m,x,t} = e^{\varepsilon_{x,t}} + E_t [M_{t+1} \Sigma_{m,x,t+1}] \)  

(44)

\( \Sigma_{m,t} = 1 + E_t [M_{t+1} \Sigma_{m,t+1}] \).  

(45)

Using **Lemma 1** and **Lemma 2**, the discounted value of both terms is given by

\[
E_1 [M_2 \cdot \Sigma_{m,x,2}] = e^{\gamma (\varepsilon_{m,1} - \varepsilon_{m})} \sum_{t=2}^{\infty} \beta_m^{t-1} e^{\mu_{a,t} + \frac{1}{2} \sigma_{a,t}^2},
\]  

(46)

\[
E_1 [M_2 \cdot \Sigma_{m,2}] = e^{\gamma (\varepsilon_{m,1} - \varepsilon_{m})} \sum_{t=2}^{\infty} \beta_m^{t-1} e^{\mu_{b,t} + \frac{1}{2} \sigma_{b,t}^2},
\]  

(47)

where

\[
\mu_{a,t} = -\gamma^{t-1} \rho_m^{t-1} (\varepsilon_{m,1} - \varepsilon_{m}) + \rho_a^{t-1} \varepsilon_{x,1}
\]  

(48)

\[
\mu_{b,t} = -\gamma^{t-1} \rho_m^{t-1} (\varepsilon_{m,1} - \varepsilon_{m})
\]  

(49)

\[
\sigma_{a,t}^2 = \gamma^2 \sigma_m^2 + \frac{1 - \rho_m^2}{1 - \rho_m^2} \sigma_x^2 - 2 \gamma \rho_m \sigma_m \sigma_x [1 - \rho_m \rho_x] - \rho_m \rho_x [1 - \rho_m \rho_x]
\]  

(50)

\[
\sigma_{b,t}^2 = \gamma^2 \sigma_m^2 + \frac{1 - \rho_m^2}{1 - \rho_m^2}
\]  

(51)
The manager's utility at time $t = 1$ is given by

$$ U_1 = \max_{I_1} \{ u_1 + E_1 [M_2 U_2] \} $$

$$ = [s + \beta(1 - s)(1 + \lambda \Phi_e)] C_1 $$

$$ + [(\alpha + s) + \beta(1 - \alpha - s)(1 + \lambda \Phi_e)] X_1 - \beta(1 + \lambda \Phi_e) (I_1 + \Psi(I_1)) $$

$$ + [\alpha + s + \beta(1 - \alpha - s)] K_2^\theta E_1 [M_2 \cdot \Sigma_{mx,2}] - \beta \delta(1 + \frac{a}{2} \cdot \delta) K_2 E_1 [M_2 \cdot \Sigma_{m,2}]. \quad (52) $$

Differentiating $U_1$ with respect to $I_1$, the marginal cost and benefit of $I_1$ are given as follows:

$$ MC_{I_1} = \beta(1 + \lambda \Phi_e) \left( 1 + \frac{I_1}{K_1} \right), \quad (53) $$

$$ MB_{I_1} = (\alpha + s + \beta(1 - \alpha - s)) M_2 \cdot \Sigma_{mx,2} \left( \theta K_2^{\theta - 1} \right) $$

$$ - \beta \delta(1 + \frac{a}{2} \cdot \delta) E_1 [M_2 \cdot \Sigma_{m,2}]. \quad (54) $$

Differentiating $(MC_{I_1}/\beta)$ and $(MB_{I_1}/\beta)$ with respect to $\alpha$ gives

$$ \frac{\partial (MC_{I_1}/\beta)}{\partial \alpha} = 0, \quad (55) $$

$$ \frac{\partial (MB_{I_1}/\beta)}{\partial \alpha} = \left( \frac{1}{\beta} - 1 \right) E_1 \left[ M_2 \cdot \Sigma_{mx,2} \left( \theta K_2^{\theta - 1} \right) \right] > 0. \quad (56) $$

Because per $\beta$ marginal benefit increases with $\alpha$ and the sensitivity of per $\beta$ marginal cost equals to 0, the optimal investment for a manager increases with $\alpha$. The proof for $s$ is similar.

Differentiating $(MC_{I_1}/\beta)$ and $(MB_{I_1}/\beta)$ with respect to $\beta$ gives

$$ \frac{\partial (MC_{I_1}/\beta)}{\partial \beta} = 0, \quad (57) $$

$$ \frac{\partial (MB_{I_1}/\beta)}{\partial \beta} = - \left( \gamma + s \right) E_1 \left[ M_2 \cdot \Sigma_{mx,2} \left( \theta K_2^{\theta - 1} \right) \right] < 0. \quad (58) $$

Similarly, we can prove the optimal investment for a manager decreases with $\beta$. \qed

**Proof of Proposition 2.**
Proposition 2. The optimal investment for a shareholder decreases with \( \alpha \) and \( s \) if \( 0 < \beta < 1 \), will not be affected by \( \beta \) if \( 0 < \beta < 1 \), and increases with \( \sigma_x \) under a general condition. Moreover, \( \tilde{I}_1 \) is always lower than \( I_1 \) when there exists agency issues, i.e.,

\[
\frac{\partial \tilde{I}_1}{\partial \alpha} < 0, \quad \frac{\partial \tilde{I}_1}{\partial s} < 0, \quad \text{if} \quad 0 < \beta < 1,
\]
\[
\frac{\partial \tilde{I}_1}{\partial \beta} = 0, \quad \text{if} \quad 0 < \beta < 1,
\]
\[
\frac{\partial \tilde{I}_1}{\partial \sigma_x} > 0, \quad \text{if} \quad \frac{\sigma_x}{\gamma \rho_{mx} \sigma_m} > \max \left[ \frac{1 - \rho^2}{1 - \rho_m \rho_x}, 1 \right],
\]
\[
\tilde{I}_1 < I_1, \quad \text{if} \quad \alpha \geq 0, \quad s \geq 0, \quad \alpha + s \neq 0 \quad \text{and} \quad 0 < \beta < 1.
\]

Proof. The firm’s value from a shareholder’s perspective at time \( t = 1 \) is given by

\[
V_1 = \max_{\tilde{I}_1} \{ d_1 + E_1[M_2V_2(1)] \}
= (1 + \lambda \Phi_e) \left[ (1 - s)C_1 + (1 - \alpha - s)X_1 - \tilde{I}_1 - \Psi(\tilde{I}_1) \right]
+ (1 - \alpha - s) K_2 E_1[M_2 \cdot \Sigma_{m:2}] - \delta(1 + \frac{a}{2} \cdot \delta) K_2 E_1[M_2 \cdot \Sigma_{m:2}]. \tag{59}
\]

Differentiating \( V_1 \) with respect to \( \tilde{I}_1 \), the marginal effects for the hypothetical shareholder who also holds \( \beta \) portion of the firm’s total equity are given as follows:

\[
MC_{\tilde{I}_1} = \beta (1 + \lambda \Phi_e) \left( 1 + a \frac{I_1}{K_1} \right), \tag{60}
\]
\[
MB_{\tilde{I}_1} = \beta (1 - \alpha - s) E_1[M_2 \cdot \Sigma_{m:2} \left( \theta K_2^{\theta-1} \right)] - \beta \delta(1 + \frac{a}{2} \cdot \delta) E_1[M_2 \cdot \Sigma_{m:2}]. \tag{61}
\]

Because \( MC_{\tilde{I}_1} = MC_{I_1} \) and \( MB_{\tilde{I}_1} < MB_{I_1} \) when there exists agency issues, \( \tilde{I}_1 \) is always lower than \( I_1 \).

Differentiating \( \left( MC_{\tilde{I}_1}/\beta \right) \) and \( \left( MB_{\tilde{I}_1}/\beta \right) \) with respect to \( \alpha \) gives

\[
\frac{\partial \left( MC_{\tilde{I}_1}/\beta \right)}{\partial \alpha} = 0, \tag{62}
\]
\[
\frac{\partial \left( MB_{\tilde{I}_1}/\beta \right)}{\partial \alpha} = -E_1 \left[ M_2 \cdot \Sigma_{m,x,2} \left( \theta K_2^{-1} \right) \right] < 0. \tag{63}
\]

Thus, \( \tilde{I}_1 \) decreases with \( \alpha \). The proof for \( s \) is similar.

Differentiating \( \left( MC_{\tilde{I}_1}/\beta \right) \) and \( \left( MB_{\tilde{I}_1}/\beta \right) \) with respect to \( \beta \) gives

\[
\frac{\partial \left( MC_{\tilde{I}_1}/\beta \right)}{\partial \beta} = \frac{\partial \left( MB_{\tilde{I}_1}/\beta \right)}{\partial \beta} = 0. \tag{64}
\]

Thus, \( \tilde{I}_1 \) will not be affected by \( \beta \).

Differentiating \( \left( MC_{\tilde{I}_1}/\beta \right) \) and \( \left( MB_{\tilde{I}_1}/\beta \right) \) with respect to \( \sigma_x \) gives

\[
\frac{\partial \left( MC_{\tilde{I}_1}/\beta \right)}{\partial \sigma_x} = 0, \tag{65}
\]

\[
\frac{\partial \left( MB_{\tilde{I}_1}/\beta \right)}{\partial \sigma_x} = (1 - \alpha - s) \theta K_2^{-1} \frac{\partial E_1}{\partial \sigma_x} \left[ M_2 \cdot \Sigma_{m,x,2} \right]. \tag{66}
\]

According to Eq. (46), differentiating \( \sigma_{a,t}^2 \) with respect to \( \sigma_x \) gives

\[
\frac{\partial \sigma_{a,t}^2}{\partial \sigma_x} = 2\sigma_x \left[ 1 - \frac{\rho_x^2 (t-1)}{1 - \rho_x^2} \right] - 2\gamma \rho_{m,x} \sigma_m \left[ 1 - \frac{\rho_x^t \rho_{m,x}^{t-1}}{1 - \rho_{m,x} \rho_x} \right]. \tag{67}
\]

Under the condition \( \frac{\sigma_x}{\gamma \rho_{m,x} \sigma_m} > \max \left[ \frac{1 - \rho_x^2}{1 - \rho_{m,x} \rho_x}, 1 \right] \), \( \frac{\partial \sigma_{a,t}^2}{\partial \sigma_x} \) is always positive. Thus, \( \tilde{I}_1 \) increases with \( \sigma_x \). \( \square \)

**Proof of Proposition 3.**

**Proposition 3.** The optimal cash holding for a manager increases with \( \alpha \) if \( 0 < \beta < 1 \), increases with \( s \) if \( \beta (1 + \lambda) < 1 \) and \( 0 < \beta < 1 \), and decreases with \( \beta \) if \( s > 0 \), i.e.,

\[
\frac{\partial C_1}{\partial \alpha} \geq 0, \quad \text{if} \quad 0 < \beta < 1,
\]

\[
\frac{\partial C_1}{\partial s} > 0, \quad \text{if} \quad \beta (1 + \lambda) < 1, \quad 0 < \beta < 1,
\]

\[
\frac{\partial C_1}{\partial \beta} < 0, \quad \text{if} \quad s > 0.
\]
Proof. Differentiating $U_0$ with respect to $C_1$ gives:

$$\frac{\partial U_0}{\partial C_1} = -\frac{\beta}{R} + E_0 \left[ M_1 \frac{\partial U_1}{\partial C_1} \right],$$

$$= -\frac{\beta}{R} + E_0 \left[ M_1 \left\{ [s + \beta(1-s)(1+\lambda \Phi_e)] - \beta (1 + \lambda \Phi_e) \left( \frac{\partial I_1}{\partial C_1} + \frac{\partial \Psi (I_1)}{\partial C_1} \right) \right. \right.$$

$$+ \left[ \alpha + s + \beta (1 - \alpha - s) \right] \frac{\partial E_0}{\partial C_1} \right]\left[ M_2 \cdot \Sigma_{m_2} (K_2^d) \right],$$

$$- \beta \delta \left( 1 + \frac{a}{\delta} \right) \frac{\partial E_0}{\partial C_1} \left( M_2 \cdot \Sigma_{m_2} (K_2) \right).$$

(68)

Substituting the FOC of investment into Eq.(68), the marginal cost and benefit of $C_1$ are defined as follows:

$$MC_{C_1} = \frac{\beta}{R}, (69)$$

$$MB_{C_1} = E_0 \left[ M_1 [s + \beta(1-s)(1+\lambda \Phi_e)] \right]. (70)$$

First, differentiating $(MC_{C_1}/\beta)$ and $(MB_{C_1}/\beta)$ with respect to $\alpha$ gives

$$\frac{\partial (MC_{C_1}/\beta)}{\partial \alpha} = 0, \quad (71)$$

$$\frac{\partial (MB_{C_1}/\beta)}{\partial \alpha} = (1 - s) \frac{\partial E_0}{\partial \alpha} \left[ M_1 (1 + \lambda \Phi_e) \right]. \quad (72)$$

According to Proposition 1, the optimal investment for a manager increases with $\alpha$. Given a fixed $C_1$, a higher $\alpha$ implies higher investment as well as higher probability of external financing, which means $\frac{\partial E_0[M_1(1+\lambda \Phi_e)]}{\partial \alpha} \geq 0$. Thus, $\frac{\partial C_1}{\partial \alpha} \geq 0$.

Then, differentiating $(MC_{C_1}/\beta)$ and $(MB_{C_1}/\beta)$ with respect to $s$, if $\beta (1 + \lambda) < 1$ and $0 < \beta < 1$, the sensitivity is given by

$$\frac{\partial (MC_{C_1}/\beta)}{\partial s} = 0, \quad (73)$$

$$\frac{\partial (MB_{C_1}/\beta)}{\partial s} = E_0 \left[ M_1 \left[ \frac{1}{\beta} - (1 + \lambda \Phi_e) \right] \right] + (1 - s) \frac{\partial E_0}{\partial s} \left[ M_1 (1 + \lambda \Phi_e) \right]. \quad (74)$$
Using **Proposition 1**, the lower bound of \( \frac{\partial (MB_{C_1}/\beta)}{\partial s} \) is given by

\[
\frac{\partial (MB_{C_1}/\beta)}{\partial s} \geq \left[ 1 - \frac{\beta (1 + \lambda)}{\beta} \right] E_0[M_1] > 0.
\]  

(75)

Thus, the optimal cash saving for a manager increases with \( s \).

Last, consider the sensitivity of optimal cash saving \( C_1 \) to equity share \( \beta \). If \( s > 0 \), we have

\[
\frac{\partial (MC_{C_1}/\beta)}{\partial \beta} = 0,
\]

(76)

\[
\frac{\partial (MB_{C_1}/\beta)}{\partial \beta} = -\left( \frac{s}{\beta^2} \right) E_0[M_1] + (1 - s) \frac{\partial E_0[M_1 (1 + \lambda \Phi_e)]}{\partial \beta} < 0.
\]

(77)

Because per \( \beta \) marginal benefit decreases with \( \beta \) and the sensitivity of per \( \beta \) marginal cost equals to 0, the optimal cash saving for a manager decreases with \( \beta \).

\( \square \)

**Proof of Proposition 4.**

**Proposition 4.** The optimal cash holding for a shareholder decreases with \( \alpha \) and \( s \) and not be affected by \( \beta \). Moreover, \( C_1 \) is always lower than \( \tilde{C}_1 \) if \( s > 0 \) and \( 0 < \beta < 1 \), i.e.,

\[
\frac{\partial \tilde{C}_1}{\partial \alpha} \leq 0, \quad \frac{\partial \tilde{C}_1}{\partial s} < 0, \quad \frac{\partial \tilde{C}_1}{\partial \beta} = 0.
\]

\( \tilde{C}_1 < C_1 \), if \( s > 0 \) and \( 0 < \beta < 1 \).

**Proof.** The marginal effects are given by

\[
MC_{\tilde{C}_1} = \frac{\beta}{R},
\]

(78)

\[
MB_{\tilde{C}_1} = \beta (1 - s) E_0[M_1 (1 + \lambda \Phi_e)].
\]

(79)

Because \( \tilde{I}_1 < I_1 \) and \( MB_{\tilde{C}_1} < MB_{C_1} \), then \( C_1 < \tilde{C}_1 \). Using **Proposition 2**, we can prove

\[
\frac{\partial (MB_{\tilde{C}_1}/\beta)}{\partial \alpha} = (1 - s) \frac{\partial E_0[M_1 (1 + \lambda \Phi_e)]}{\partial \alpha} \leq 0.
\]

(80)
Thus, \( \frac{\partial \tilde{C}_1}{\partial \alpha} \leq 0, \frac{\partial \tilde{C}_1}{\partial s} < 0 \) and \( \frac{\partial \tilde{C}_1}{\partial \beta} = 0 \).

\[ \frac{\partial (MB \tilde{C}_1 / \beta)}{\partial s} = -E_0 [M_1 (1 + \lambda \Phi_e)] + (1 - s) \frac{\partial E_0 [M_1 (1 + \lambda \Phi_e)]}{\partial s} < 0. \quad (81) \]

\[ \frac{\partial (MB \tilde{C}_1 / \beta)}{\partial \beta} = 0. \quad (82) \]

\[ \frac{\partial E_0 [M_1 (1 + \lambda \Phi_e)]}{\partial s} < 0. \]

Proof of Theorem II.1

Proof. Since \( \frac{\partial \Delta C_1}{\partial \alpha} = \frac{\partial C_1}{\partial \alpha} - \frac{\partial \tilde{C}_1}{\partial \alpha} \), using Proposition 3 and Proposition 4, Theorem 1 can be proved. □

Proof of Theorem II.2

Proof. Since \( \frac{\partial \Delta I_1}{\partial \alpha} = \frac{\partial I_1}{\partial \alpha} - \frac{\partial \tilde{I}_1}{\partial \alpha} \), using Proposition 1 and Proposition 2, Theorem 2 can be proved. □

Proof of Theorem II.3

Proof. The definition of profitability gives

\[ \pi = \frac{K_2^{\theta-1} E_1 [M_2 \cdot \Sigma_{mx,2}]}{E_1 [M_2 \cdot \Sigma_{m,2}]} \quad (83) \]

Differentiating \( \pi \) with respect to \( \alpha \) gives

\[ \frac{\partial \pi}{\partial \alpha} = \frac{\partial \pi}{\partial K_2} \frac{\partial K_2}{\partial \alpha}. \quad (84) \]

According to Proposition 1 and Proposition 2, we can prove \( \frac{\partial \pi}{\partial \alpha} < 0, \frac{\partial \pi}{\partial s} < 0, \frac{\partial \pi}{\partial \beta} > 0 \) and \( \pi < \tilde{\pi} \). Substituting the FOC of investment into Eq. (83) gives

\[ \tilde{\pi} = \frac{(1 + \lambda \Phi_e) \left( 1 + \frac{a}{\tilde{I}_1} \right)}{\theta (1 - \alpha - s) E_1 [M_2 \cdot \Sigma_{m,2}]} + \frac{\delta (1 + \frac{a}{2} \cdot \delta)}{\theta (1 - \alpha - s)}. \quad (85) \]

Because \( \frac{\partial \tilde{I}_1}{\partial \sigma_x} > 0 \), then \( \frac{\partial \tilde{\pi}}{\partial \sigma_x} > 0 \). □

Proof of Theorem II.4
Proof. The marginal effects of investment for the hypothetical shareholder are given by

\[ MC_{\tilde{I}_1} = \beta (1 + \lambda \Phi) \left( 1 + a \frac{I_1}{K_1} \right), \quad (86) \]
\[ MB_{\tilde{I}_1} = \beta (1 - \alpha - s) E_1 \left[ M_2 \cdot \Sigma_{m,x,2} \left( \theta K_2^{a-1} \right) \right] - \beta \delta (1 + \frac{a}{2} \cdot \delta) E_1 \left[ M_2 \cdot \Sigma_{m,2} \right]. \quad (87) \]

The ignorance of agency issues directly misleads shareholders' perception of the observed firm cash and investment decisions by incorrectly interpreting cash-hoarding and over-investment as strong firm fundamental, which gives

\[ \tilde{I}_1 = I_1 \quad (88) \]
\[ \frac{MC_{I_1}}{MC_{\tilde{I}_1}} = \frac{MB_{I_1}}{MB_{\tilde{I}_1}} \quad (89) \]

Solving the equation, the relation between \( E_1^S [M_2 \cdot \Sigma_{m,x,2}] \) and \( E_1 [M_2 \cdot \Sigma_{m,x,2}] \) is given by

\[ \frac{E_1^S [M_2 \cdot \Sigma_{m,x,2}]}{E_1 [M_2 \cdot \Sigma_{m,x,2}]} = 1 + \frac{\alpha + s}{\beta (1 - \alpha - s)}. \quad (90) \]

The firm value is

\[ \frac{E_1^S [M_2 V_2]}{E_1 [M_2 V_2]} = \frac{(1 - \alpha - s) K_2^{a} E_1^S [M_2 \cdot \Sigma_{m,x,2}] - \delta (1 + \frac{a}{2} \cdot \delta) K_2 E_1 [M_2 \cdot \Sigma_{m,2}]}{(1 - \alpha - s) K_2^{a} E_1 [M_2 \cdot \Sigma_{m,x,2}] - \delta (1 + \frac{a}{2} \cdot \delta) K_2 E_1 [M_2 \cdot \Sigma_{m,2}]}, \quad (91) \]
\[ \geq \frac{E_1^S [M_2 \cdot \Sigma_{m,x,2}]}{E_1 [M_2 \cdot \Sigma_{m,x,2}]} = 1 + \frac{\alpha + s}{\beta (1 - \alpha - s)}. \quad (92) \]

\[ \square \]

Proof of Theorem II.5

Proof. According to the definition of Tobin’s q

\[ Q = \frac{E_1 [M_2 V_2]}{K_2} = (1 - \alpha - s) K_2^{a-1} E_1 [M_2 \cdot \Sigma_{m,x,2}] - \delta (1 + \frac{a}{2} \cdot \delta) E_1 [M_2 \cdot \Sigma_{m,2}], \quad (93) \]
\[ Q^S = \frac{E_1^S [M_2 V_2]}{K_2} = (1 - \alpha - s) K_2^{a-1} E_1^S [M_2 \cdot \Sigma_{m,x,2}] - \delta (1 + \frac{a}{2} \cdot \delta) E_1 [M_2 \cdot \Sigma_{m,2}]. \quad (94) \]
Differentiating the true Tobin’s q with respect to $\alpha$ gives

$$\frac{\partial Q}{\partial \alpha} = -K_2^{\theta-1}E_1 [M_2 \cdot \Sigma_{m,2}] + \frac{\partial Q}{\partial K_2} \frac{\partial K_2}{\partial \alpha}. \quad (95)$$

Because $\frac{\partial Q}{\partial K_2} < 0$ and $\frac{\partial K_2}{\partial \alpha} > 0$, then we have

$$\frac{\partial Q}{\partial \alpha} < 0. \quad (96)$$

Substituting the FOC of investment into Eq.(94) gives

$$Q^S = \frac{1}{\theta} \left[ (1 + \lambda \Phi_e) \left( 1 + a \frac{I_1}{K_1} \right) \right] + \left( \frac{1}{\theta} - 1 \right) \delta (1 + \frac{a}{2} \cdot \delta)E_1 [M_2 \cdot \Sigma_{m,2}]. \quad (97)$$

Differentiating the subjective Tobin’s q with respect to $\alpha$, the sensitivity is given by

$$\frac{\partial Q^S}{\partial \alpha} = \frac{\partial Q^S}{\partial I_1} \frac{\partial I_1}{\partial \alpha}. \quad (98)$$

Because $\frac{\partial Q^S}{\partial I_1} > 0$ and $\frac{\partial I_1}{\partial \alpha} > 0$, then we have

$$\frac{\partial Q^S}{\partial \alpha} > 0. \quad (99)$$

The proof for $s$ is similar. □

**Appendix: Data Construction**

All the variables are constructed using CRSP data and Compustat (North America) Annual data. All names in parentheses refer to the Compustat item name. We use common shares (shrcd = 10 and 11) of firms traded on NYSE, Amex and Nasdaq and exclude firms from financial (SIC 6000-6999) and utility (SIC 4000-4999) sectors. Our sample period starts from July 1970 and ends in December 2016.

- Firm expense ratio (XR): (Selling, General and Administrative Expense (item XSGA) - Research and Development Expense (item XRD))/ (Sales (item SALE) - Cost of Goods Sold (item COGS))
• Cash-to-asset ratio (CHR): Cash and short-term investments (item CHE) / Total Assets (item AT)
• Cash Flow (CF): Earnings before Interest (item EBITDA) / Total Assets (item AT)
• Investment Rate (IK): Capital Expenditures (item CAPX) ÷ Sale of Property (item SPPE) / 0.5 × (Net Property Plant and Equipment (item PPENT) + lagged PPENT)
• Book Debt (BD): Long-Term Debt Total (item DLTT) + Debt in Current Liabilities Total (item DLC)
• Tobin’s Q (Market-to-Book): (Common Shares Outstanding (item CSHO) × Annual Fiscal Year Price Close (item PRCC_F) + Book Debt (BD)) / Total Assets (item AT)
• External Financing (EF): (Long-Term Debt Issuance (item DLTIS) - Long-Term Debt Reduction (item DLTR) + Sale of Common and Preferred Stock (item SSTK)) / Total Assets (item AT)
• Distributions (DISB): (Dividends Common (item DVC) + Dividends Preferred (item DVP) + Purchase of Common and Preferred Stock (item PRSTKC)) / Total Assets (item AT)
• Firm profitability (ROA): Operating Income Before Depreciation (item oibdp) / lagged Total Assets (item AT)

References


### Table 1. Parameter Settings

This table presents parameter values used in the simulation. Group I includes parameters relate to firm fundamentals. Parameters in Group II relate to SDF and parameters in Group III depict key parameters in the managerial compensation structure.

<table>
<thead>
<tr>
<th>Notation</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group I</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\lambda$</td>
<td>0.043</td>
<td>Cost of external financing</td>
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<tr>
<td>$\delta$</td>
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<td>Depreciation rate</td>
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<tr>
<td>$\theta$</td>
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<tr>
<td>$\sigma_x$</td>
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<td>Standard deviation of the innovation to productivity shock</td>
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<td>$\rho_{mx}$</td>
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<td>Correlation between productivity shock and SDF shock</td>
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<tr>
<td><strong>Group II</strong></td>
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<tr>
<td>$\beta_m$</td>
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<tr>
<td>$\gamma$</td>
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<tr>
<td>$\rho_m$</td>
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<tr>
<td>$\sigma_m$</td>
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<td>Conditional volatility of shock in SDF</td>
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<tr>
<td>$\beta$</td>
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<td>Managerial equity share</td>
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Table 2. Characteristics of decile IXR sorted portfolios

The table reports average firm investment-related and financial characteristics of deciles sorted based on firm’s industry-adjusted expense ratio (IXR): the log of market capitalization (SZ), cash-to-asset ratio (CHR), the log of book-to-market ratio (BM), investment rate (IK), cash flow (CF), external financing (EF), distributions (DISB), return on asset (ROA), and Tobin’s q. The sample covers all U.S. public firms listed on the NYSE/AMEX/NASDAQ except for firms in financial (SIC 6000-6999) and utility (SIC 4000-4999) sectors. The sample period is from July 1970 to December 2016.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>N</th>
<th>IXR</th>
<th>SZ</th>
<th>CHR</th>
<th>BM</th>
<th>IK</th>
<th>CF</th>
<th>EF</th>
<th>DISB</th>
<th>ROA</th>
<th>Tobin’s q</th>
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Table 3. Characteristics of decile cash-to-assets portfolios

The table reports average firm investment-related and financial characteristics of deciles sorted based on firm’s cash-to-asset ratio (CHR) among firms with less severe agency costs (the smallest 8 deciles in Table 2): the log of market capitalization (SZ), industry-adjusted expense ratio (IXR), the log of book-to-market ratio (BM), investment rate (IK), cash flow (CF), external financing (EF), distributions (DISB), return on asset (ROA), and Tobin’s q. The sample covers all U.S. public firms listed on the NYSE/AMEX/NASDAQ except for firms in financial (SIC 6000-6999) and utility (SIC 4000-4999) sectors. The sample period is from July 1970 to December 2016.

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<thead>
<tr>
<th>Portfolio</th>
<th>N</th>
<th>CHR</th>
<th>SZ</th>
<th>IXR</th>
<th>BM</th>
<th>IK</th>
<th>CF</th>
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<th>DISB</th>
<th>ROA</th>
<th>Tobin’s q</th>
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</tr>
<tr>
<td>3</td>
<td>222.6</td>
<td>0.029</td>
<td>2,733</td>
<td>-0.212</td>
<td>0.950</td>
<td>0.121</td>
<td>0.144</td>
<td>0.033</td>
<td>0.023</td>
<td>0.185</td>
<td>1.132</td>
</tr>
<tr>
<td>4</td>
<td>222.5</td>
<td>0.045</td>
<td>2,643</td>
<td>-0.213</td>
<td>0.938</td>
<td>0.120</td>
<td>0.145</td>
<td>0.032</td>
<td>0.024</td>
<td>0.189</td>
<td>1.166</td>
</tr>
<tr>
<td>5</td>
<td>222.4</td>
<td>0.066</td>
<td>2,642</td>
<td>-0.220</td>
<td>0.880</td>
<td>0.123</td>
<td>0.148</td>
<td>0.030</td>
<td>0.025</td>
<td>0.195</td>
<td>1.218</td>
</tr>
<tr>
<td>6</td>
<td>222.7</td>
<td>0.096</td>
<td>2,858</td>
<td>-0.229</td>
<td>0.844</td>
<td>0.128</td>
<td>0.150</td>
<td>0.030</td>
<td>0.027</td>
<td>0.205</td>
<td>1.327</td>
</tr>
<tr>
<td>7</td>
<td>222.6</td>
<td>0.136</td>
<td>2,601</td>
<td>-0.238</td>
<td>0.786</td>
<td>0.133</td>
<td>0.154</td>
<td>0.030</td>
<td>0.029</td>
<td>0.217</td>
<td>1.448</td>
</tr>
<tr>
<td>8</td>
<td>222.5</td>
<td>0.195</td>
<td>2,072</td>
<td>-0.250</td>
<td>0.734</td>
<td>0.142</td>
<td>0.155</td>
<td>0.037</td>
<td>0.032</td>
<td>0.233</td>
<td>1.651</td>
</tr>
<tr>
<td>9</td>
<td>222.6</td>
<td>0.284</td>
<td>1,804</td>
<td>-0.263</td>
<td>0.668</td>
<td>0.156</td>
<td>0.152</td>
<td>0.049</td>
<td>0.031</td>
<td>0.254</td>
<td>1.923</td>
</tr>
<tr>
<td>10</td>
<td>222.1</td>
<td>0.480</td>
<td>1,766</td>
<td>-0.290</td>
<td>0.602</td>
<td>0.175</td>
<td>0.136</td>
<td>0.086</td>
<td>0.033</td>
<td>0.275</td>
<td>2.367</td>
</tr>
<tr>
<td>10-1</td>
<td>-0.069***</td>
<td>-0.398***</td>
<td>0.051***</td>
<td>-0.007***</td>
<td>0.050***</td>
<td>0.016***</td>
<td>0.092***</td>
<td>1.261***</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(-31.43) (-47.48) (28.02) (-2.54) (20.73) (37.89) (57.56) (43.36)
The table reports average firm investment-related and financial characteristics of deciles sorted based on firm’s expense ratio (IXR) among firms with large agency costs (the largest 2 deciles in Table 2): the log of market capitalization (SZ), cash-to-asset ratio (CHR), the log of book-to-market ratio (BM), investment rate (IK), cash flow (CF), external financing (EF), distributions (DISB), return on asset (ROA), and Tobin’s q. The sample covers all U.S. public firms listed on the NYSE/AMEX/NASDAQ except for firms in financial (SIC 6000-6999) and utility (SIC 4000-4999) sectors. The sample period is from July 1970 to December 2016.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>N</th>
<th>IXR</th>
<th>SZ</th>
<th>CHR</th>
<th>BM</th>
<th>IK</th>
<th>CF</th>
<th>EF</th>
<th>DISB</th>
<th>ROA</th>
<th>Tobin’s q</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>113.9</td>
<td>0.107</td>
<td>367.7</td>
<td>0.116</td>
<td>1.185</td>
<td>0.113</td>
<td>0.076</td>
<td>0.030</td>
<td>0.017</td>
<td>0.107</td>
<td>1.072</td>
</tr>
<tr>
<td>2</td>
<td>113.5</td>
<td>0.167</td>
<td>221.5</td>
<td>0.127</td>
<td>1.236</td>
<td>0.115</td>
<td>0.046</td>
<td>0.038</td>
<td>0.015</td>
<td>0.076</td>
<td>1.098</td>
</tr>
<tr>
<td>3</td>
<td>113.5</td>
<td>0.269</td>
<td>174.3</td>
<td>0.148</td>
<td>1.264</td>
<td>0.113</td>
<td>-0.009</td>
<td>0.054</td>
<td>0.014</td>
<td>0.026</td>
<td>1.170</td>
</tr>
<tr>
<td>4</td>
<td>113.5</td>
<td>0.545</td>
<td>121.3</td>
<td>0.190</td>
<td>1.244</td>
<td>0.131</td>
<td>-0.117</td>
<td>0.106</td>
<td>0.012</td>
<td>-0.074</td>
<td>1.444</td>
</tr>
<tr>
<td>5</td>
<td>113.1</td>
<td>3.454</td>
<td>134.5</td>
<td>0.260</td>
<td>1.059</td>
<td>0.160</td>
<td>-0.292</td>
<td>0.222</td>
<td>0.014</td>
<td>-0.235</td>
<td>2.164</td>
</tr>
<tr>
<td>5-1</td>
<td>0.144***</td>
<td>-0.126***</td>
<td>0.047***</td>
<td>-0.368***</td>
<td>0.192***</td>
<td>-0.003***</td>
<td>-0.342***</td>
<td>1.092***</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(33.03) (-11.60) (20.84) (-72.44) (35.99) (-7.89) (-71.28) (38.05)
Table 5. Cash holding, agency costs and cross-section of stock returns.

The table reports equal-weighted and value-weighted average returns and alphas, in percentage points, for stock portfolios sorted based on firm’s expense ratio (IXR) and cash-to-asset ratio (CHR). Panel A reports average returns for decile portfolios sorted by IXR. Panel B reports average returns for decile portfolios sorted by CHR among firms with less severe agency costs (the smallest 8 deciles in Table 2). Panel C reports average returns for quintile portfolios sorted by IXR among firms with large agency costs (the largest 2 deciles in Table 2). The sample covers all U.S. common stocks listed on the NYSE/AMEX/NASDAQ except for firms in financial (SIC 6000-6999) and utility (SIC 4000-4999) sectors. The sample period is from July 1970 to December 2016.

<table>
<thead>
<tr>
<th>Panel A. Returns on IXR sorted portfolios.</th>
<th>Equal</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portfolio rex</td>
<td>CAPM</td>
<td>FF-3</td>
</tr>
<tr>
<td>1</td>
<td>0.79</td>
<td>0.13</td>
</tr>
<tr>
<td>2</td>
<td>0.89</td>
<td>0.16</td>
</tr>
<tr>
<td>3</td>
<td>0.95</td>
<td>0.23</td>
</tr>
<tr>
<td>4</td>
<td>0.97</td>
<td>0.28</td>
</tr>
<tr>
<td>5</td>
<td>1.06</td>
<td>0.39</td>
</tr>
<tr>
<td>6</td>
<td>0.99</td>
<td>0.33</td>
</tr>
<tr>
<td>7</td>
<td>0.97</td>
<td>0.33</td>
</tr>
<tr>
<td>8</td>
<td>0.98</td>
<td>0.35</td>
</tr>
<tr>
<td>9</td>
<td>0.95</td>
<td>0.29</td>
</tr>
<tr>
<td>10</td>
<td>0.51</td>
<td>-0.26</td>
</tr>
<tr>
<td>10-1</td>
<td>-0.28</td>
<td>-0.39*</td>
</tr>
<tr>
<td></td>
<td>(-1.27)</td>
<td>(-1.74)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B. Returns on cash-to-assets portfolios in the normal group.</th>
<th>Equal</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portfolio rex</td>
<td>CAPM</td>
<td>FF-3</td>
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<tr>
<td>1</td>
<td>0.75</td>
<td>0.11</td>
</tr>
<tr>
<td>2</td>
<td>0.85</td>
<td>0.19</td>
</tr>
<tr>
<td>3</td>
<td>0.87</td>
<td>0.22</td>
</tr>
<tr>
<td>4</td>
<td>0.85</td>
<td>0.19</td>
</tr>
<tr>
<td>5</td>
<td>0.94</td>
<td>0.28</td>
</tr>
<tr>
<td>6</td>
<td>1.01</td>
<td>0.35</td>
</tr>
<tr>
<td>7</td>
<td>1.07</td>
<td>0.39</td>
</tr>
<tr>
<td>8</td>
<td>1.02</td>
<td>0.32</td>
</tr>
<tr>
<td>9</td>
<td>1.01</td>
<td>0.29</td>
</tr>
<tr>
<td>10</td>
<td>1.10</td>
<td>0.37</td>
</tr>
<tr>
<td>10-1</td>
<td>0.35**</td>
<td>0.26</td>
</tr>
<tr>
<td></td>
<td>(2.04)</td>
<td>(1.51)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel C. Returns on IXR sorted portfolios in the agency group.</th>
<th>Equal</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portfolio rex</td>
<td>CAPM</td>
<td>FF-3</td>
</tr>
<tr>
<td>1</td>
<td>1.01</td>
<td>0.36</td>
</tr>
<tr>
<td>2</td>
<td>0.91</td>
<td>0.25</td>
</tr>
<tr>
<td>3</td>
<td>0.99</td>
<td>0.30</td>
</tr>
<tr>
<td>4</td>
<td>0.58</td>
<td>-0.17</td>
</tr>
<tr>
<td>5</td>
<td>0.16</td>
<td>-0.64</td>
</tr>
<tr>
<td>5-1</td>
<td>-0.85***</td>
<td>-1.00***</td>
</tr>
<tr>
<td></td>
<td>(-3.44)</td>
<td>(-4.12)</td>
</tr>
</tbody>
</table>
Figure 1. Optimal policy functions. The figure depicts the MC and the MB of cash holding (left panel) and investment (right panel) for a manager and a hypothetical shareholder who owns a same equity stake. In both panels, thin solid lines, thick solid lines and dashed lines represent the MC curve, MB curve for the manager and MB curve for the shareholder, respectively. Optimal policy functions are determined by the intersection of cost and benefit curves.
Figure 2. Firm decisions and agency frictions. This figure depicts the optimal cash (the upper row) and investment (the bottom row) policy for both the manager (solid line) and a hypothetical shareholder who owns a same equity stake (dashed line) at different firm fundamentals $\sigma_x$. Cash is defined as $C_1/K_1$ and investment is defined as $E_0(I_1)/K_1$. To investigate the marginal effect of $\sigma_x$ on each misalignment parameter, we let one of friction parameters be non-zero and shut down the other frictions. In the plot, we set $\alpha = 25/10000$ and $s = 0.55/10000$. The horizontal dashed lines represent possible observed firm policies while $\sigma_x$ (blue dots) and $\sigma^S_x$ (red dots) represent the true parameter value in firm productivity shock process of Eq.2 and shareholder’s subjective perception, respectively.
Figure 3. Firm intrinsic value and equity returns. This figure depicts the sensitivity of firm value and expected return to different parameters. We include the profit-sharing parameter, \( \alpha \), the tunneling parameter, \( s \), managerial ownership, \( \beta \), and the conditional volatility of productivity shock, \( \sigma_x \) in the simulation. The upper row presents both firm’s objective value taking into account potential agency costs (\( V^O \)) and subjective value ignoring such cost (\( V^S \)) while the bottom row presents the expected equity return when shareholders fail to include agency costs in the valuation.