Firms' Cash Holdings and the Cross–Section of Equity Returns [†]

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Abstract

This paper proposes a real option model of investment in which firms face a non trivial capital structure decision between internal and external funding. In the model, riskier firms (i.e. firms with cash flows more highly correlated with an aggregate shock) are more likely to use costly external funding to finance their growth options. For this reason, they save more. This precautionary savings motive is the key ingredient that allows the model to generate a positive correlation between expected equity returns and firms' cash holdings. The latter prediction is supported by the data.

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1 Introduction

Cash holdings are an important component of a firm's capital structure. The average cash–to–assets ratio for American public companies has increased from 10% in 1980 to 24% in 2004. The determinants of corporate cash holdings and its time series properties have been widely studied in the literature.[1] However, the link between this variable and the cross–section of equity returns has not been fully explored yet.

In this paper, I show that a positive correlation between cash holdings and average equity returns emerges in a model in which firms face a trade–off between the choices of distributing dividends in the current period and accumulating cash to avoid external financing.

When external financing is costly, firms can hoard cash to finance future growth options at a lower cost. At the same time, if corporate savings bear a cost for the shareholders, a trade–off arises. In such a situation, a manager has to decide whether to distribute dividends or to save cash thus avoiding costly external financing in the future. Kim et al. [1998] exploit this trade–off to study the determinants of corporate cash holdings. They describe the optimal cash policy of a firm in a three–period environment with risk neutral investors and constant risk–free interest rate. Their model is able to explain many empirical regularities including the negative correlation of cash holdings with book–to–market and firm size, and the positive correlation of cash holdings with the firm's growth options.

The model presented here amends the real option framework of Berk et al. [1999] to allow for the non–trivial capital structure decision analyzed by Kim et al. [1998]. Like in Berk et al. [1999], at the beginning of each period, a manager has the option of installing a productive asset whose cash flows are correlated with an aggregate shock. In their framework, the investment expenditure is entirely equity financed. In my setup, the manager can finance investment by means of retained earnings or equity. Equity issuance involves pecuniary costs, such as bankers' and lawyers' fees. Savings allow the firm to avoid costly equity financing, but earn a return lower than the one that shareholders would obtain on their own. By departing from the Modigliani–Miller world of Berk et al. [1999], I have the opportunity to study how time varying discount rates (i.e. the presence of

[1] In this paper, corporate cash holdings are identified with a firm's cash–to–assets ratio. See Bates et al. [2006] for an empirical analysis of the evolution of the cash–to–asset ratio for American public companies in the last 30 years. An early study of the determinants of corporate cash holdings is the paper by Opler et al. [1999]. Dittmar and Mahrt-Smith [2007] study how corporate governance influences cash holdings valuation.

risk averse investors) affect not only the manager's investment decision, but also the choice between external and internal financing.

In the latter case, riskier firms (i.e. firms with cash flows more highly correlated with an aggregate shock) have the highest hedging needs because they are more likely to experience a cash flow shortfall in those states in which they need external financing the most. For this reason, they save more than less risky firms. This affects risk premia. Acharya et al. [2007a] explore the role of financial policies as tools available to the firm to hedge against cash flows shortfalls, but they do not link financial policies to financial market risk premia. This paper contributes to the literature on corporate hedging by explicitly studying the relation between corporate hedging policies and risk premia[2].

A three–period version of the model is able to highlight the main mechanism that generates a positive correlation between cash holdings and equity returns, but it is not suitable to replicate any of the empirical analysis performed with the data. For this reason, I also develop an infinite horizon version (*dynamic trade–off model*) to simulate a panel of firms and study the cross–sectional implications of corporate precautionary savings for equity returns.

Recently, infinite horizon models that exploit the trade–off between costly external financing and costly corporate savings have been used to study the determinants and the value of corporate cash holdings. For example, Riddick and Whited [2008] show that in an infinite horizon set–up the firm's propensity to save out of cash flows is negative. Gamba and Triantis [2008] develop a model that allows them to extend the model of Riddick and Whited [2008] by studying debt and savings policies independently. They show that corporate liquidity is more valuable for small/younger firms because it allows them to improve their financial flexibility. Moreover, they also show that combinations of debt and cash holdings that produce the same value of net debt have a different impact on the financial flexibility of the firm[3]. Riddick and Whited [2008] and Gamba and Triantis

[2] Other models that provide a theory of optimal corporate savings choice are Almeida et al. [2004] and Acharya et al. [2007b]. These models share with the work of Kim et al. [1998] the three–periods structure and the risk–neutral environment, but not the trade–off between costly external financing and costly accumulation of cash. Huberman [1984] provides an early study of the role of corporate savings as hedge against earnings shortfall. His model rationalizes the negative relation between firms' market value and savings. Froot et al. [1993] propose a framework to analyze optimal financial hedging strategies and extensive references to alternative models of financial risk management.

[3] Eisfeldt and Rampini [2007] exploit the same trade–off between equity financing and savings to study the value of aggregate liquidity. Differently from Riddick and Whited [2008] and Gamba and Triantis [2008], they develop a general equilibrium model whose main prediction is that the value of aggregate liquidity (*liquidity premium*) is counter–cyclical. Other recent papers develop dynamic models of the firm's investment and savings decisions in a continuous time framework. Bolton et al. [2009] present the model closest to the one described in this paper. The

[2008] do not explicitly model the correlation of the firm's cash flows with an aggregate source of risk. This prevents them from to studying the link between the cross–section of equity returns and capital structure decisions, which is the focus of Gomes and Schmid [2008] and Livdan et al. [2008].

Gomes and Schmid [2008] show that, each time a growth option is exercised, the firm becomes less risky and more levered. This argument rationalizes the negative relation between book leverage and average excess returns. In their model cash can either be distributed as dividends to shareholders or invested in new real assets. Livdan et al. [2008], on the contrary, develop a model where the manager can issue risk–free corporate debt and save cash. They show that the higher the shadow price of new debt, the lower the firm's ability to finance all the desired investment. As a consequence, the correlation of dividends with the business cycle increases, leading to higher risk and higher expected returns. On the other hand, Livdan et al. [2008] do not study directly the determinants of corporate precautionary savings and the role of the latter in shaping the cross-section of equity returns, which is the focus of this paper.

The infinite horizon version generates two main predictions: (1) a positive relation between corporate cash holdings and average equity returns only emerges after controlling for book–to–market; (2) this positive relation survives when size and the firm's market beta are considered among the regressors. These findings are supported by the data when I run Fama–MacBeth cross–sectional regressions of equity returns on firms' characteristics.

Given that cash holdings carry a positive expected premium, I also create 75 portfolios applying a conditional sorting on size, book–to–market and cash holdings to explore if firms with a high cash–to–assets ratio earn a positive and signicant excess returns over firms with a low cash–to–assets ratio. I find that, after controlling for the sources of risk proxied by the three Fama–French and the Momentum factors (Fama and French [1993], Carhart [1997]), firms with a high cash–to–assets ratio earn a positive excess return – from a minimum of 27 basis points per month (b.p.m.) to a maximum of 93 b.p.m. – over firms with a low cash–to–assets ratio. A *Cash factor* – called High Cash minus Low Cash ($HCMLC$) – accounts for the differences in returns.

The Cash factor, constructed following George and Hwang [2008], can be interpreted as the excess return of an investment strategy that is long in stocks of firms with a high cash–to–assets

set–up is similar to the one of Riddick and Whited [2008], with the important difference that their firm specific productivity shock is not persistent. They derive an optimal *double–barrier* cash policy very similar to the one developed here. See also the works of Asvanunt et al. [2007], Copeland and Lyasoff [2008], and Nikolov [2009].

ratio (High Cash portfolio) and short in stocks of firms with a low cash–to–assets ratio (Low Cash portfolio). This investment strategy produces an average excess return of 42 b.p.m. that is not explained by the linear four–factor model. The Cash factor improves the explanation of the variation of average returns across the 75 portfolios. When I add *HCMLC*, the cross–sectional GLS R^2 increases from 0.22 to 0.33. This is evidence that *HCMLC* is a mimicking portfolio for sources of risk different from those proxied by the Fama–French and Momentum factors that might be related to the risk of a future cash flow shortfall, as suggested by the model.[4]

The outline of the paper is as follows. In Section 2, a simple financing problem in a three–period framework highlights how a precautionary savings motive can generate a positive correlation between cash holdings and average equity returns. The infinite horizon model is described in section 3, while the calibration procedure, the simulated optimal financing policies, and the the simulated cross–sectional regressions are discussed in section 4. Section 5 contains the empirical analysis. Section 7 concludes.

2 A three–period model

In this section, I develop a model that departs from the risk neutral set–up of Kim et al. [1998] by adding a stochastic discount factor and cash flows correlated with systematic risk.

A firm that expects to have an investment opportunity in the near future needs to decide whether to hoard cash, earning a return lower than the opportunity cost of capital, or distribute dividends in the current period, thus increasing the expected cost of future investment. This trade–off determines the current period optimal saving policy.

The assumption that cash flows are correlated with the aggregate risk introduces a precautionary saving motive that induces riskier firms to save more. This precautionary savings motive – absent in a risk neutral environment – is the key ingredient that generates a positive correlation between expected equity returns and a firm's cash holdings.

[4] In a closely related paper, Simutin [2009] independently finds that firms with high excess cash holdings (ECM) earn a positive and significant excess return over low excess cash holdings firms (around 40 b.p.m). He also documents that the spread increases during economic booms and that, in the subsequent 10 years, high ECM firms experience higher investment–to–asset ratios than low ECM firms. Faulkender and Wang [2006] use excess stock returns to measure the market value of corporate cash holdings. They find that cash is more valuable when the level of cash holdings is low, leverage is low, and the firm is financially constrained.

2.1 Set–up

Consider a three–period model, with periods indexed by $t = 0, 1, 2$. At time $t = 0$, a firm is endowed with initial cash holdings equal to C_0 and an asset (the *risky asset*) that produces a random cash flow in period 1 only.

At time 1, after the realization of the risky asset's cash flow, the firm receives an investment opportunity with probability π, $\pi \in [0, 1]$. The opportunity consists of the option of installing an asset (the *safe asset*) that produces a deterministic cash flow, C_2, at time 2 . I assume that C_2 is not pledgeable at time $t = 1$.

If the firm installs the safe asset, then it pays a fixed (sunk) cost $I = 1$. If the firm does not have enough internal resources to pay for the fixed cost, then it can issue equity. The assumption of a stochastic cash flow together with a deterministic investment cost generates a liquidity shock and a consequent need for external financing at time $t = 1$.

The unit cost of issuing equity is λ. The firm can also transfer cash from one period to the next at the internal gross rate $\widehat{R} < R$, where R is the risk–free gross interest rate. An internal accumulation rate less than the risk–free interest rate can be justified by the fact that the firm pays corporate taxes on interest earned on savings[5]. This assumption prevents an unbounded accumulation of cash internally to the firm. The firm faces a trade–off between distributing dividends today or retaining cash in order to avoid costly external financing tomorrow. The timing of the model is illustrated in Figure 1.

2.2 Pricing kernel and production

For the purposes of asset valuation, I introduce a stochastic discount factor (SDF), adopting the convenient parameterization of Berk, Green, and Naik [1999]. A cash flow produced at time $t = 1$ is discounted using the factor

$$M_1 = e^{m_1} = e^{-r-\frac{1}{2}\sigma_z^2-\sigma_z\varepsilon_{z,1}}, \tag{2.1}$$

[5]This assumption is needed to generate bounded corporate savings. A lower return on corporate savings can be justified assuming agency costs. Dittmar and Mahrt-Smith [2007] document that poor corporate governance affects negatively the value of a firm's cash resources. In this paper, I follow Riddick and Whited [2008]. They introduce a tax penalty on savings, while personal interest and dividend taxes are not modeled for simplicity.

where $\varepsilon_{z,1} \sim N(0,1)$ is the aggregate shock at time $t = 1$.[6] The formulation in equation (2.1) implies that the conditional mean of the SDF, $E_0[M_1]$, is equal to the inverse of the gross risk–free interest rate, e^{-r}.

the risky asset produces a pay–off equal to e^{x_1} at time 1 , where

$$x_1 = \mu - \frac{1}{2}\sigma_x^2 + \sigma_x \varepsilon_{x,1}. \tag{2.2}$$

The *idiosyncratic shock*, $\varepsilon_{x,1} \sim N(0,1)$, is correlated with the error term of the pricing kernel. The latter assumption makes the cash flows produced by the asset in place at time 0 risky. I assume that $COV(\varepsilon_{z,1}, \varepsilon_{x,1}) = \sigma_{x,z}$ and, as a consequence, $COV(x_1, m_1) = -\sigma_x \sigma_z \sigma_{x,z}$. As in Berk, Green, and Naik [1999], the *systematic risk* of a project's cash flow, β_{xm}, is equal to $\sigma_x \sigma_z \sigma_{x,z}$.

The value at time zero of the cash flow that will be realized at time 1 is given by the certainty equivalent discounted at the (gross) risk–free interest rate:

$$E_0[e^{m_1} e^{x_1}] = E_0[e^{-r - \frac{1}{2}\sigma_z^2 - \sigma_z \varepsilon_{z,1} + \mu - \frac{1}{2}\sigma_x^2 + \sigma_x \varepsilon_{x,1}}] = e^{-r} e^{-\beta_{xm}}.$$

As β_{xm} increases, the cash flow becomes more correlated with the aggregate shock, hence less valuable.

2.3 The firm's problem

At time 0, the firm has to decide how much of the initial cash endowment C_0 to distribute as dividends (D_0) and how much to retain as savings (S_1). Given that the return on internal savings is lower than the risk–free rate, S_1 will always be less than C_0.

To simplify the problem, I assume that the time 1 present discounted value of the *safe project*'s cash flow, $\frac{C_2}{R}$, is greater than the investment cost when the safe project is entirely equity financed,

[6] Assume that in the background there is a consumer with CRRA preferences, log–normal consumption growth – $\log(\frac{c_{t+1}}{c_t}) \sim N(\mu_c, \sigma_c^2)$ – and discount factor $\beta = 1/R$. It follows that

$$M_{t+1} = \beta\Big(\frac{c_{t+1}}{c_t}\Big)^{-\gamma} \qquad \Rightarrow \qquad \log(M_{t+1}) = -\log(R) - \gamma(\log(c_{t+1}) - \log(c_t)).$$

Because of the log-normality of consumption growth, the logarithm of the pricing kernel is the sum of the (negative) risk–free interest rate plus a normally distributed error term. Setting $-\gamma(\log(c_{t+1}) - \log(c_t))$ equal to $-\frac{1}{2}\sigma_z^2 - \sigma_z \varepsilon_{z,1}$ allows me to recover equation (2.1). For a similar interpretation see Zhang [2005].

$1+\lambda$. This condition is sufficient to ensure that the firm always invests at time 1 if there is an investment opportunity.

Conditional on investing at time 1, the firm issues equity only if corporate savings, S_1, plus the cash flow from the risky asset, e^{x_1}, are not enough to pay for the cost of investment. In this case, the dividend at time 1, D_1, is negative and the firm pays λD_1 in issuance costs. The last period dividend is the cash flow produced by the safe asset, $D_2 = C_2$. If the firm does not invest at time 1, all the internal resources are distributed to shareholders and the time 2 dividend is zero.

The problem of the firm can be written as

$$V_0 \equiv \max_{S_1 \geq 0} D_0 + E_0[M_1 D_1] + E_0[M_2 D_2], \tag{2.3}$$

where

$$D_0 = C_0 - \frac{S_1}{\widehat{R}},$$

$$D_1 = \begin{cases} (1+\lambda\Delta_1)(S_1 + e^{x_1} - 1) & \text{with probability } \pi \\ \\ S_1 + e^{x_1} & \text{with probability 1-}\pi \end{cases},$$

$$D_2 = \begin{cases} C_2 & \text{with probability } \pi \\ \\ 0 & \text{with probability } 1-\pi \end{cases},$$

$$M_2 = \exp(-2r - \frac{1}{2}\sigma_z^2 - \sigma_z \varepsilon_{z,2}),$$

and Δ_1 is an indicator function that takes value 1 if the internal resources at time 1 are not enough to pay for the fixed cost of investment ($e^{x_1} + S_1 < 1$). M_2 is the pricing kernel needed to evaluate a random pay–off in period 2. Proposition A.1, in the Appendix, provides a condition for the existence and the uniqueness of an interior solution for the firm's problem.

Assuming an interior solution, the optimal saving policy is such that the firm equates the cost and the benefit of saving an extra unit of cash:

$$1 \;=\; \widehat{R}E_0\big[M_1\big] + \pi\lambda\widehat{R}E_0\big[M_1\Delta_1\big]. \tag{2.4}$$

The marginal cost is simply the foregone dividend at time 0. The marginal benefit is given by the expected dividend that the firm will distribute next period plus the expected reduction in issuance cost if the firm will issue equity. Figure 2 shows that this value is decreasing in S_1.

Figure 3 depicts the firm's optimal savings policy as a function of the cash flow's mean, the probability of getting an investment opportunity, the cost of external financing, and the risk–free rate. These results are summarized in Proposition A.4.

As the mean of cash flows increases, the firm expects to have more liquid resources to finance the investment and this causes a reduction in the marginal benefit of saving. Hence, the firm optimally lowers the time 0 amount of retained cash.

Without the equity issuance cost, the firm does not save because the return on internal savings is less than the risk–free interest rate. On the other hand, a positive value of λ generates a positive expected financing cost. Hence, an increase in λ produces an increase in the marginal benefit of retaining cash and this, in turn, induces the firm to retain more cash.

The marginal benefit of retaining cash is also increasing in the probability of receiving an investment opportunity because a higher probability of investing next period produces a higher expected financing cost.

The risk–free rate measures the opportunity cost of internal savings. The higher the risk–free rate relative to the internal rate, the lower the marginal benefit of retaining cash for the firm. As the ratio $R/\widehat{R}$ increases, it becomes more expensive for the firm to accumulate cash internally and as a consequence the amount of cash transferred to the next period is reduced.

2.4 Risk, savings, and expected equity returns

In this section, I explain how the covariance of the risky asset's cash flow with aggregate risk affects the firm's savings decision and expected returns.

Exploiting the properties of the covariance between two random variables, I rewrite the Euler equation in (2.4) as

$$1 \;=\; \widehat{R}E_0[M_1] + \pi\lambda\widehat{R}\Big(E_0[M_1]Prob_0(\Delta_1 = 1) + COV[M_1, \Delta_1]\Big).$$

Under risk–neutrality, the covariance term disappears from the Euler equation and risk plays no role in determining the firm's optimal saving policy. Here, by contrast, an increase in the covariance term will lower the expected value of the firms' cash flows in those future states in which the firm is more likely to issue equity (namely when the firm decides to invest and the realization of the aggregate shock is low). As a consequence, an increase in riskiness leads to an increase in the time $t = 1$ expected financing cost and the firm reacts by increasing savings at time 0. This comparative static property is illustrated in the left panel of Figure 4 and formalized in Proposition A.2.

The expected return between time 0 and time 1 is the ratio of the time 0 expected future dividends over the time 0 ex–dividend value of the firm:

$$E[R^e_{0,1}] \;=\; \frac{E_0[D_1 + E_1(\frac{M_2}{M_1}D_2)]}{E_0[M_1D_1] + E_0[M_2D_2]}. \tag{2.5}$$

When the cash flows are uncorrelated with the stochastic discount factor the expected equity return is equal to the risk–free return R. On the other hand, when there is no investment opportunity ($\pi = 0$) or no equity issuance cost ($\lambda = 0$) the optimal policy for the firm is to set $S^*_1 = 0$. This will make the expected equity return independent of the saving policy. These three cases are of no interest if the objective is the analysis of the relation between savings and expected equity returns. Hence, risk, a positive expectation of future investment, and costly external financing are essential ingredients to explore the link between cash holdings and equity returns.

A change in the firm's *systematic risk* affects expected returns through two channels. The first channel works through the direct effect of a change in σ_{xz}. An increase in risk will reduce the time 0 ex–dividend value of the firm while the expected future dividends are not affected:

expected return will increase. At the same time, a change in σ_{xz} will affect the optimal choice of S_1^* (Proposition A.2). Both the numerator and the denominator in equation (2.5) depend positively on the optimal level of firm's savings. This indirect effect moves the time 0 ex–dividend value and the expected future dividends in the same direction, so the overall effect on expected equity returns is indeterminate. In the appendix, I provide a sufficient condition under which an increase in σ_{xz} leads to higher expected equity returns (Proposition A.3) and I also show that the sufficient condition holds for a wide range of plausible values for σ_x and μ. The right panel of Figure 4 illustrates the positive relation between risk and expected equity returns.

In the next section, I extend the three–period model to an infinite horizon set–up so that I can use simulation methods to generate a panel of heterogenous firms and replicate some of the empirical analysis performed with the data.

3 An infinite horizon model

This section describes the infinite horizon version of the three–period model. The timing – illustrated in Figure 5 – is as follows. A firm starts period t endowed with an amount of internal resources equal to the cash flows produced by the assets in place plus the savings accumulated from the previous period. At the beginning of each period, the firm has the option of installing an asset. After the investment decision has been taken, the firm chooses the amount of dividends to distribute/equity to raise and the amount of cash to retain. Assets are subject to stochastic depreciation. The latter happens before the period ends.

In the next section, this model is calibrated to match some key quantities and simulated to generate an artificial panel of firms used to study the relation between cash holdings and the cross–section of equity returns.

3.1 Interest rate and pricing kernel

The pricing kernel is very similar to the one described in Section 2.2. The only difference is that the one period risk–free interest rate is time–varying so that the model can generate time–varying average expected returns. The autoregressive process governing the evolution of the risk–

free interest rate is

$$r_{t+1} \quad = \quad (1-\rho)\bar{r} + \rho r_t + \sigma_r \varepsilon_{r,t+1}.$$

The unconditional mean of the risk–free interest rate is $\bar{r}$, the persistence ρ and the conditional variance is σ_r. The shock to the risk–free rate, $\varepsilon_{r,t+1} \sim N(0,1)$, is assumed to be independent and identically distributed.

The pricing kernel used at time t to evaluate a pay–off at time $t+1$ is

$$M_{t+1} = e^{m_{t+1}} = e^{-r_t - \frac{1}{2}\sigma_z^2 - \sigma_z \varepsilon_{z,t+1}}. \tag{3.1}$$

The *aggregate shock*, $\varepsilon_{z,t+1} \sim N(0,1)$, is correlated with the shock to the firm's cash flows. This correlation is described in the next section.

The conditional mean of M_{t+1} is equal to the inverse of the gross risk–free interest rate. In addition, the implied Sharpe ratio – the ratio between the conditional standard deviation and conditional mean of the stochastic discount factor – is constant and equal to $\sqrt{e^{\sigma_z^2} - 1}$. The Sharpe ratio is used to calibrate the value for σ_z.

3.2 Production

Assets differ with respect to their risk. An asset of type h (high risk asset) has a higher correlation with the aggregate shock than an asset of type l (low risk asset). At the beginning of each period, a firm draws a low risk investment opportunity (i.e. the firm can install a low risk asset) with probability θ and a high risk investment opportunity with probability $1-\theta$, $\theta \in [0,1]$. If the firm decides to invest, it has to pay a fixed cost equal to I. In what follows, the cost of investment is normalized to 1 to simplify the notation. This can be done without loss of generality.

The pay–off of an asset at time t is equal to $e^{x_{i,t}}$, where $x_{i,t}$ is the following normal random variable:

$$x_{i,t} = \mu - \frac{1}{2}\sigma_x^2 + \sigma_x \varepsilon_{i,t} \qquad i = h, l. \tag{3.2}$$

The *idiosyncratic shock* in (3.2), $\varepsilon_{i,t} \sim N(0,1)$, is assumed to be correlated with the aggregate shock in (3.1). The variance–covariance matrix among $\varepsilon_{z,t+1}$, $\varepsilon_{h,t+1}$ and $\varepsilon_{l,t+1}$ is equal to

$$\begin{pmatrix} 1 & \sigma_{h,z} & \sigma_{l,z} \\ \sigma_{h,z} & 1 & \sigma_{h,z}\sigma_{l,z} \\ \sigma_{l,z} & \sigma_{h,z}\sigma_{l,z} & 1 \end{pmatrix},$$

where $\sigma_{i,z}$ is the correlation of $\varepsilon_{i,t+1}$ with the aggregate shock $\varepsilon_{z,t+1}$ and $\sigma_{h,z} > \sigma_{l,z} > 0$. It follows that an individual asset correlation with the pricing kernel is equal to $-\sigma_x\sigma_z\sigma_{i,z}$.

A simple pricing exercise helps in explaining the role played by the correlation between the aggregate and idiosyncratic shocks. Let $\beta_{x_i,z} = \sigma_x\sigma_z\sigma_{i,z}$ and assume that a firm has n assets in place. The present discounted value of the cash flows that will be produced tomorrow by the n assets in place is

$$\pi E_t\left[e^{m_{t+1}}\sum_{i=1}^{n} e^{x_{i,t+1}}\right] = \pi e^{-r_t+\mu}\sum_{i=1}^{n} e^{-\beta_{x_i,z}}. \tag{3.3}$$

As in Berk et al. [1999], I define a firm's average systematic risk, $\beta_{x,z}$, to be an average of the individual assets' correlation with the pricing kernel so that I can rewrite equation (3.3) as

$$\pi E_t\left[e^{m_{t+1}}\sum_{i=1}^{n} e^{x_{i,t+1}}\right] = \pi n e^{\mu} e^{-\beta_{x,z}} e^{-r_t}, \tag{3.4}$$

where $\beta_{x,z}$ is equal to $-\log\left(\sum_{i=1}^{n}\frac{e^{-\beta_{x_i,z}}}{n}\right)$. Equation (3.4) has a natural interpretation: the present discounted value of tomorrow's cash flows is the certainty equivalent – given by the expected value of the cash flows ($\pi n I e^{\mu}$) multiplied by a risk adjustment ($e^{-\beta_{x,z}}$) – discounted using the risk–free interest rate.

The last assumption concerns stochastic depreciation. In this model, assets currently in place can disappear randomly. I define $Y_{i,j}$ to be an i.i.d. random variable associated with an asset in place j of type i that takes value 0 with probability π and value 1 with probability $1-\pi$. If $Y_{i,j}$ is equal to zero then the asset will be lost, otherwise it survives to the next period.

3.3 Financing

In each period, the firm has to decide whether to invest or not and, conditional on the investment decision, how much dividends to distribute/equity to issue and how much cash to retain. The firm takes these decisions knowing the number of high risk assets ($n_{h,t}$), the number of low risk assets ($n_{l,t}$), the savings accumulated from the previous period (S_t), the current level of the risk–free interest rate (r_t) and the quality of the new investment opportunity (Q_t). Q_t takes a value of one if the new investment is of the low risk type, otherwise Q_t is equal to zero.

Let $n_{h,t}$ and $n_{l,t}$ be the beginning of period number of type h and type l assets in place respectively. Then the after cash profits generated by the $(n_{h,t} + n_{l,t})$ assets are equal to $(1 - \tau)\Big(\sum_{j=0}^{n_{l,t}} e^{x_{l,j}} + \sum_{k=0}^{n_{h,t}} e^{x_{h,k}}\Big)$. The sources of funds are the after tax profits generated at the beginning of time t by the assets in place plus corporate savings, S_t. The uses of funds are equal to dividends distributions, D_t, plus the (discounted) amount of cash that the firm decides to have at the beginning of the next period, S_{t+1}, plus the fixed cost of investment if the firm decides to install a new asset. Retaining cash is costly because the firm pays the corporate tax, τ, on the interest earned on savings so that the internal accumulation rate is $\widehat{R}_t = e^{r_t} - \tau(e^{r_t} - 1) < e^{r_t} = R_t$, where R_t is the gross risk–free interest rate at time t.

Let $\mathcal{I}_t$ be an indicator variable that equals one if the firm invests at time t and zero otherwise. Then the firm's budget constraint can be written as

$$S_t + (1 - \tau)\left(\sum_{j=0}^{n_{l,t}} e^{x_{l,j}} + \sum_{k=0}^{n_{h,t}} e^{x_{h,k}}\right) = D_t + \frac{S_{t+1}}{\widehat{R}_t} + \mathcal{I}_t. \tag{3.5}$$

If $D_t < 0$, the firm can raise equity by paying a percentage issuance cost equal to λ. I define Δ_t to be an indicator variable that takes value of one if the firm issues equity ($D_t < 0$) and zero otherwise, so that the return paid by the firm to the shareholders at time t is equal to $(1 + \lambda\Delta_t)D_t$.

Given the above assumptions, a trade–off arises between the choice of distributing dividends in the current period and the choice of saving cash in order to avoid costly external financing in the next period. This trade–off determines the firm's optimal savings decision.

3.4 Equity valuation

The value of equity – equal to the present discounted value of the firm's future dividends – is the solution to[7]

$$V(n_h, n_l, C, r, Q) \equiv \max_{D,\mathcal{I},S' \geq 0} (1+\lambda\Delta)D + E\Big[\ M'V(n_h', n_l', C', r', Q')\Big] \tag{3.6}$$

subject to:

$$C = D + \frac{S'}{\widehat{R}} + \mathcal{I}, \tag{3.7}$$

$$C' = S' + (1-\tau)\left(\sum_{j=0}^{n_l'} e^{x_{l,j}} + \sum_{k=0}^{n_h'} e^{x_{h,k}}\right), \tag{3.8}$$

$$n_h' = \sum_{j=1}^{n_h+Q\mathcal{I}} Y_{h,j}' \qquad n_l' = \sum_{k=1}^{n_l+(1-Q)\mathcal{I}} Y_{l,k}', \tag{3.9}$$

$$Prob\big(Y_{i,j}' = 1\big) = \pi \qquad Prob\big(Y_{i,j}' = 0\big) = 1-\pi \qquad i{=}h,l \qquad \forall\ j,\ k\ .$$

To simplify the notation, a new variable, C, is introduced. C is defined as the sum of after tax profits plus the amount of cash transfered internally from the previous period and it summarizes the total amount of the beginning of period internal resources available to the firm. Because of this transformation, the firm's budget constraint can be rewritten as in equation (3.7). The law of motion for C is described by equation (3.8).

Equation (3.9) describes the law of motion of the assets in place as a function of the realizations of the i.i.d. random variables $Y_{i,j}$. This law of motion depends on the realization of Q only if the firm decides to invest in the current period ($\mathcal{I} = 1$).

[7]From now on time indexes are suppressed and next period values are denoted with a prime.

3.5 Optimal financing policy

By the envelope condition, the Euler equation for savings is

$$(1+\lambda\Delta) \geq \widehat{R}E\Big[M'(1+\lambda\Delta')\Big].$$

In what follows, I assume an interior solution and I also assume that the firm does not issue equity in the current period, so that $\Delta = 0$. Under such assumptions, the Euler equation becomes

$$1 \;=\; \frac{\widehat{R}}{R} + \frac{\widehat{R}}{R}\lambda Prob(\Delta' = 1) + \frac{\widehat{R}}{R}\lambda COV[\tilde{M}', \Delta'], \tag{3.10}$$

where I have exploited the fact that $E[M'] = 1/R$, $E[M'\Delta'] = E[M']E[\Delta'] + COV[M', \Delta']$, $E[\Delta'] = Prob(\Delta' = 1)$ and $M' = e^{-r}e^{-\frac{1}{2}\sigma_z^2 - \sigma_z\varepsilon'_z} = R^{-1}\tilde{M}'$.

Equation (3.10) is the analogue of equation (2.5): the firm equates the marginal cost of saving an extra unit of cash – the forgone dividend in the current period – to the marginal benefit – the expected dividend that the firm will distribute next period plus the expected reduction in issuance cost if the firm will need to issue equity.

Having risky assets is not necessary to generate a precautionary saving motive. Without the covariance term, the Euler equation resembles the one in Riddick and Whited [2008]. In such a situation, firms with the same number of assets in place (equal size) will choose the same saving policy because the probability of issuing equity next period is the same for all of them.

In this model, risk induces heterogeneity in savings policies controlling for firm's size. When cash flows are correlated with the aggregate shock, riskier firms will expect lower cash flows in those future states where there is investment and the realization of the aggregate shock is low. As a consequence, riskier firms save more to reduce the expected financing cost everything else being equal.

To study how the probability of investing next period affects the optimal savings policy it is sufficient to notice that a firm will issue equity next period only if it decides to invest. As a consequence, the probability of issuing equity next period is just equal to the probability of investing next period multiplied by the probability of issuing equity conditional on investing. Bearing this in mind, the Euler equation can be rewritten including the probability of investing next period as

$$1 \quad = \quad \frac{\widehat{R}}{R} + \frac{\widehat{R}}{R}\lambda Prob(\mathcal{I}' = 1)Prob(\Delta' = 1|\mathcal{I}' = 1) + \frac{\widehat{R}}{R}\lambda COV[\tilde{M}', \Delta'].$$

If the probability of investing next period is zero, then the firm will never retain cash because the probability of issuing costly equity is zero. On the other hand, the marginal benefit of retaining an extra unit of cash is increasing in the probability of investing next period, hence the precautionary motive is stronger in times when investment opportunities are likely to arise.

4 Calibration

The model's parameters are divided among the three groups listed in Table I. The first group includes parameter values taken from other studies. The proportional equity issuance cost is set equal to 0.1, a value close to the *seven percent* rule found by Chen and Ritter [2000]. Following Riddick and Whited [2008], the corporate tax rate τ is set equal to 0.3 and the survival probability of each installed asset π equal to 0.85.

The second group contains the four parameters governing the processes for the pricing kernel and interest rate: $\rho, \bar{r}, \sigma_r, \sigma_z$. I set the first three to match the unconditional mean, the unconditional variance, and the first order autocorrelation of the annual risk–free interest rate over the post war period. The remaining parameter, σ_z, is chosen to match the value of the Sharpe ratio.

The last group is made up of the parameters that govern the production process: μ, σ_x, β_h, β_l, θ. I set their values to match five unconditional moments: average equity premium, standard deviation of equity premium, average investment–to–capital ratio, average book–to–market ratio, and average savings–to–capital ratio.

The theoretical counterpart of the value of equity is the ex–dividend value of the firm at the end of each period before the death of the assets in place. Following Zhang [2005] and Gomes and Schmid [2008], the one–period equity return at time t is the ratio between the value of the firm at time t and the ex–dividend value of the firm at time $t-1$:

$$R_{t-1,t} = \frac{V_t}{V_{t-1} - D_{t-1}}. \tag{4.1}$$

The accounting variables are also evaluated at the end of each period. Total assets at time t (A_t) are equal to the amount of internal resources that are transferred to the next period ($S_{t+1}/\widehat{R}_t$) plus the book value of capital ($n_{l,t} + n_{h,t}$). The book–to–market value at time t equals the ratio of the book value of capital to the ex–dividend value of equity: $BM_t = \frac{K_t}{V_t - D_t}$. The last two variables targeted in the calibration exercise are the investment–to–capital ratio, defined as the cost of investment (I) over the book value of capital (K_t), and the cash–to–capital ratio, defined as the amount of internal resources that are transferred to the next period ($S_{t+1}/\widehat{R}_t$) over the book value of capital (K_t). In Table II, the calibrated values are compared to their empirical counterparts.

4.1 Optimal policies

This section illustrates how the precautionary saving motive affects the optimal savings policy. I consider three firms that have invested in the current period and have six assets in place. The low–risk firm only has low–risk assets installed. The medium–risk firm has three low–risk assets and three high–risk assets in place. Finally, the high–risk firm has only high–risk assets installed.

In the the left panel of Figure 6, I depict the optimal savings policy when the risk–free interest rate is at its lowest level; in the the right panel, I illustrate the optimal savings policy when the risk–free interest rate is at its highest level[8]. Similarly for dividends in Figure 7. In all the figures, quantities are reported as a function of the beginning of period cash holdings C.

Equity is only issued when internal resources are not enough to finance the cost of investment ($C < 1$). Firms retain cash if they are able to fully finance investment with internal resources ($C \geq 1$) and they distribute dividends only if they are able to save the unconstrained optimal level of cash. Notice that the high–risk firm starts to distribute dividends at a higher level of C. The model predicts that when firms can save the unconstrained optimal level of cash, riskier firms save more. The intuition for such a result is quite simple. Given that the aggregate shock is i.i.d., all firms have the same expected cash flows. The high–risk firm, however, will have lower cash flows compared to a low–risk firm conditional on a low realization of the aggregate shock, that is, exactly in the state in which the probability of external financing is the highest. Hence, the high–risk firm,

[8] In the simulation exercise, the autoregressive process for the risk–free interest rate is approximated using a three–state Markov Chain.

having a higher expected financing cost, saves more, everything else being equal.

All firms save more when the interest rate is low. This is not surprising because the calibrated values are such that a firm will invest in both types of assets when the risk–free interest rate is at its lowest level and will only invest in the low–risk assets when the risk–free interest rate is at its highest level. Such a property generates a realistic pro–cyclical investment rate and a counter–cyclical book–to–market ratio. Because of the pro–cyclicality of investment, firms save more when the risk–free interest rate is low.

Table III reports the business cycle properties of the model. During a period of low interest rates, the number of firms that invest divided by the total number of firms (*investment ratio*) is equal to 1. In such a period, the opportunity cost of investing in the riskier asset is lower and firms invest in both assets, independently of their riskiness. Given the persistence of the low interest rate state, the probability of future investment is high and firms, on average, save more and distribute less dividends. By contrast, during a period of high interest rates, firms only invest in the low risk asset and the investment ratio is now equal to 0.35. Given the lower probability of future investment, firms save less and distribute more dividends.

Figures 8 and 9 report the book–to–market ratio and the ex–dividend value of equity, respectively. The book–to–market ratio is flat for values of C less than the cost of investment, it is decreasing in C when firms save and do not distribute dividends and it is again flat when firms distribute dividends. This behavior is entirely determined by the ex–dividend value of equity because the book value of capital is constant. Two firms that differ only in C can have different book–to–market ratio. This happens when they do not distribute dividends but do retain a positive amount of cash. Given that the two firms have identical future investment opportunities, the difference in book–to–market ratio is an indirect measure of their different expected financing costs. Put differently, a higher book–to–market ratio signals a higher exposure to *financing risk*.

Expected equity returns are depicted in Figure 10. By construction, the high–risk firm has a higher expected equity return than the low–risk firm; the high–risk firm also retains more cash. Not surprisingly, the infinite horizon model is able to generate the positive relation between expected equity returns and corporate cash holdings predicted by the three–period model.

4.2 Empirical predictions

In this section, I study if the precautionary saving motive induced by financing risk affects average equity returns. For this purpose, I simulate 500 600–period long panels each containing 2000 firms. The first 200 observations are dropped from each sample. For each panel, realized excess equity returns at time t are regressed on the natural logarithm of the ex–dividend value of the firm at time $t-1$, on the natural logarithm of book–to–market ratio at time $t-1$ and on the cash–to–assets ratio at time $t-1$. I evaluate the time series averages of the cross–sectional estimates and the corresponding t–statistics dividing the time series averages by their corresponding time series standard errors.

Table IV reports the simulated cross–sectional correlation between size, book–to–market and cash–to–assets. The model is able to replicate qualitatively the negative correlations of cash–to–assets with size and book–to market, while it fails to replicate the negative correlation between size and book–to market. The reason being that larger firms have a higher fraction of their value tied to assets in place. Because of full irreversibility of the investment decision, assets in place are riskier than the growth options and as a consequence the book–to–market value of larger firms is bigger.

Table V compares the regression coefficients derived by averaging the results over the 500 simulations with their empirical counterparts. Column 1 shows that the model is qualitatively able to replicate the *size* and *value* effects found by Fama and French [1992]. In the second regression, I only use corporate savings as an explanatory variable. In the data, the regression coefficient is positive, but not significantly different from zero: equity returns and corporate savings are not correlated. On the other hand, the model generates a negative and significant correlation between equity returns and corporate savings. This negative correlation is due to the fact that firms with a larger number of assets in place are riskier and, at the same time, save less because they have higher expected cash flows.

Note that it is not sufficient to include size to generate a positive correlation between cash–to–assets and equity returns. When controlling for size, firms that save more are able to reduce their financing risk and, as a consequence, their expected equity returns decrease. This happens when a firm saves but does not distribute a dividend (see figure 10). On the other hand, a positive correlation emerges only when book–to-market is also controlled for. The inclusion of book–to–market allows the cross–sectional regression to capture the positive relation between corporate savings and expected equity returns generated by firms that transfer internally the unconstrained optimal level of resources (see figure 10).

Figure 11 illustrates how the coefficients on size, book–to–market and cash–to–assets in column 5 of table V change as β_h varies from 0.25 to 0.40[9]. When there is no heterogeneity in firms' average systematic risk ($\beta_h = \beta_l$), the coefficient on cash–to–assets has a negative sign. In such a situation, firms with the same number of assets in place have the same optimal savings policies and the negative correlation is generated by firms that are able to reduce their financing risk by saving more.

As the difference between β_h and β_l increases, the precautionary savings motive for riskier firms becomes stronger and the coefficient on cash–to–assets increases. The heterogeneity in savings policies due to the different precautionary savings motives is the key to generating the positive correlation between cash–to–assets and expected equity returns found in the data. Because there are only two types of assets in the model, the size of the generated expected risk premia are small compared to those in the data. Notice that the increase in heterogeneity in firms' average systematic risk also helps the model in generating a negative size effect and a stronger value effect. Adding more heterogeneity in the choice of assets will help the model to generate a stronger conditional correlation between corporate savings and expected equity returns, but this comes at the cost of augmenting the state space, thus making the problem computationally much harder.

5 Cash holdings and the cross–section of equity returns: portfolio analysis

5.1 Time series regressions

The decision model of the firm developed in the previous sections shows that controlling for firm's size alone is not sufficient to uncover the positive relation between corporate cash holdings and average equity returns driven by precautionary savings motives. For this reason, I create 75 port-

[9] The coefficients on size, book–to–market and cash–to–assets do not vary in a significant fashion when the same sensitivity exercise is performed using μ, σ_x or θ.

folios applying a conditional sorting on size, book–to–market and cash holdings to explore if firms with a high cash–to–assets ratio earn a positive and significant excess returns over firms with a low cash–to–assets ratio as predicted by the model.

In June of year t, stocks are sorted in three size categories (small, medium and large). Following Fama and French [1992], the size breakpoints are defined over NYSE stocks. Within each category, stocks are sorted in book–to–market quintiles and within each book–to–market quintile stocks are further sorted in cash holdings quintiles. For each of the 75 portfolios, I run a time series regression of the form:

$$R^{ei} = \alpha_i + f\beta_i' + \varepsilon_i, \tag{5.1}$$

where R_t^{ei} is the $(T \times 1)$ vector of realized equally weighted excess returns[10] for portfolio i, f is a $(T \times K)$ vector containing K risk factors, β_i is a $(1 \times K)$ vector of factor loadings for portfolio i, and the intercept α_i is the risk–adjusted return of portfolio i.

Table VI shows that firms with a high cash–to–assets ratio earn positive excess returns over firms with low cash–to–assets ratios, when the vector of risk factors includes the Momentum and the Fama–French factors only. The excess returns of high cash firms over low cash ones (*HC-LC*) are always positive – from a minimum of 27 b.p.m. to a maximum of 93 b.p.m. – and significant in all but two cases.

The differences in returns between high and low cash–to–assets ratio firms are successfully explained by a Cash factor (*HCMLC*). The Cash factor, constructed following the approach suggested by George and Hwang [2008][11], can be interpreted as the excess return of an investment strategy that is long in stocks of firms with a high cash–to–assets ratio (High Cash portfolio) and short in stocks of firms with a low cash–to–assets ratio (Low Cash portfolio).

Table VII shows that the investment strategy produces on average an excess return of 42 b.p.m. that is significantly different from zero. The HCMLC factor differs from the other standard factors in the empirical asset pricing literature for the high values of its kurtosis and skewness. Table VIII reports the correlations among the Cash factor, the Momentum factor and the Fama–French factors. The Cash factor is positively correlated with the market factor (*MKT*) and with the size factor (*SMB*) and negatively correlated with the value factor (*HML*). There is no significant cor-

[10]The results obtained using value weighted excess returns are similar and available upon request.

[11]Appendix C provides a detailed explanation on how to construct the Cash factor.

relation between MOM and the other four factors. In Table IX, I regress the cash factor on the Momentum and Fama–French factors. The R–square is small (0.34) and the intercept is positive and significant – the risk–adjusted excess returns of a strategy long in high cash firms and short in low cash firms is 71 b.p.m. . This result is evidence that the Cash factor is not generated by a linear combination of the Momentum and Fama–French factors.

In Table X the *HML* factor is replaced by *HCMLC* and the differences in excess returns (*HC-LC*) become all negative and significant in six out of fifteen cases. On the other hand, the exclusion of the *HML* factor produces spreads in the excess returns of high book–to–market versus low book–to–market firms (*HB-LB*) that are always significant. When I use all five factors (Table XI), I improve the explanation of the excess returns of high cash versus low cash firms. In this last case, only two excess returns belonging to the small size category are significantly different from zero.[12]

5.2 Cross–sectional regressions

How much of the cross–sectional variation in average returns on the 75 portfolios does the Cash factor explain? To address this question, it is common to run the following cross–sectional regressions on the 75 portfolios:

$$E_T\left[R^{ei}\right] = \gamma + \lambda'\widehat{\beta}_i + \nu_i \qquad i = 1, 2, ...75, \tag{5.2}$$

where $E_T\left[R^{ei}\right]$ is the average excess return of portfolio i, $\widehat{\beta}_i$ is the $(K \times 1)$ vector of factor loadings on portfolio i, λ is the $(K \times 1)$ vector of factor risk premia, and ν_i is the pricing error. The factor loadings have been previously estimated using the first–pass regressions described by equation 5.1.

Table VIII shows that HCMLC is highly correlated with the other factors included in the proposed linear models. This creates a problem because HCMLC might be a *spurious* factor as pointed out, among others, by Chocrane [2005, section 13.4]. There are two possible ways to address this issue. The first one suggests to report single regression betas to identify which factor can be dropped in the multi–factor regression. The second one suggests to look at the price of covariance risk rather than at the price of risk in order to identify, in a multi–factor regression model, the factors

[12]The Gibbons, Ross and Shanken F–statistics imply a rejection of the hypothesis that all risk–adjusted returns are jointly equal to zero for all the proposed factor models.

that help improving the explanation of the cross–section of equity returns[13]. I choose to report the results relative to the second approach.

Tables XII and XIII report the results of the OLS and GLS cross–sectional regressions respectively. The coefficient on each factor is the estimated price of covariance risk. The difference with the regressions described by equation 5.2 is that for each portfolio the associated loading (beta) on any factor is now replaced by the covariance between the the portfolio's returns and the factor itself. As a consequence, for each factor there will be 75 covariances instead of 75 regression coefficients (betas). For each coefficient, the first value in parenthesis is the corresponding t-statistics corrected using the methodology proposed by Shanken [1992]. The second value in parenthesis is the misspecification robust t-statistics evaluated following Kan et al. [2008]. For each of the proposed model, I report the R^2 with the corresponding standard deviation (in parenthesis). In the last two columns, I report the p–values of two tests. The first one tests the hypothesis $R^2 = 1$. This is the specification test proposed by Kan et al. [2008]. If the hypothesis $R^2 = 1$ cannot be rejected, then the model is correctly specified. The second one tests the hypothesis $R^2 = 0$, namely if the proposed model cannot explain any of the variation across the 75 portfolios.

The specification tests reject most of the models at a 5% level. The only exceptions are the models including the HCMLC factor in the OLS regressions and the model with all the factors in the GLS regressions. In addition, in the OLS case, only the linear factor models including HCMLC have some significant explanatory power on the 75 portfolios. For all the other models, the hypothesis that they cannot explain any of the variation across the 75 portfolios cannot be rejected. In the GLS case, the hypothesis $R^2 = 0$ is always rejected at a 5% level. The price of covariance risk of HCMLC is positive and always significant in all but one case. This is evidence that HCMLC helps improving the explanation of the cross–section of equity returns across the 75 portfolios.

For sake of model comparison, table XIV reports the pairwise differences in R^2 generated by the six proposed linear factor models (the corresponding p-value of the test of equality of R^2 are reported in parenthesis). It is worth noting that in the OLS case, the R^2 of the model $CAPM + HCMLC$ is not statistically different from the R^2 of the models including more factors. As a consequence, the latter models do not over–perform the more parsimonious $CAPM + HCMLC$ specification despite

[13]Section III.A in Kan et al. [2008] give a clear explanation of the difference between price of risk and price of covariance risk. Jagannathan and Wang [1998] and Kan and Robotti [2009] provide asymptotic theories for single beta models.

the higher R^2 values. In the GLS case, the model that includes all the factors out–performs all the others.

To summarize the portfolio analysis, there is robust evidence that firms with a high cash–to–assets ratio earn a positive and significant excess returns over firms with a low cash–to–assets ratio once we adjust for risk using the standard four–factor model. The Cash factor is able to explain the documented excess returns. Such a conclusion is supported by two complementary results. First, only models of risk where $HCMLC$ is included cannot be rejected at a 5% level according to the specification test proposed by Kan et al. [2008]. Second, $HCMLC$ is not a spurious factor and it adds explanatory power above and beyond the standard four–factor: the corresponding price of covariance risk is positive and significant in all but one of the proposed linear factor models.

6 Conclusion

This paper shows how the precautionary savings policies of firms can affect the cross–section of equity returns. In the proposed model, riskier firms are the ones that save the most, everything else being equal.

Assuming cash flows correlated with an aggregate source of risk is essential to generate the positive correlation between cash–to–assets and expected equity returns. This correlation introduces an additional source of precautionary savings that has been overlooked in previous works. I show that the more correlated cash flows are with an aggregate shock (riskier the firm), the more cash the firm holds as a hedge against the risk of a future cash flow shortfall (higher the savings). However, this positive correlation only emerges among firms that are able to save the unconstrained optimal amount of cash. The model shows that, controlling for the number of assets in place, the latter firms have on average a lower book–to–market ratio.

Following the model's insights, I form 75 portfolios applying a conditional sorting on size, book–to–market and cash holdings. Controlling for the sources of risk proxied by the three Fama–French and the Momentum factors, firms with a high cash–to–assets ratio earn on average a positive excess return over firms with a low cash–to–assets ratio. To account for such a difference in average returns, I create a Cash factor ($HCMLC$) and I show that adding $HCMLC$ to the four factor model greatly improves the explanation of average returns variation across the 75 portfolios. For this reason, *HCMLC* can be interpreted as a mimicking portfolio for sources of risk different from those proxied by the Fama–French and Momentum factors, among which financing risk.

Including corporate debt is a natural extension of the model presented here. In a related work, I show that firms with different precautionary saving motives have different debt capacities. That is, corporate debt issuance is more expensive for firms with cash flows more correlated with aggregate risk, everything else being equal. Net leverage, defined as the ratio of book value of debt net of cash holdings over the book value of assets, captures both the positive correlation of cash holdings and the negative correlation of book leverage with the cross–section of equity returns.

The extension of such a framework to include risky corporate debt and corporate debt with different maturities will guide us toward a better understanding of the endogeneity problem that afflicts empirical asset pricing and corporate finance. This is material for future research.

References

Acharya, V. V., Almeida, H., Campello, M., 2007a. Is cash negative debt? A hedging perspective on corporate financial policies. Journal of Financial Intermediation 16, 515–554.

Acharya, V. V., Davydenko, S. A., Strebulaev, I. A., 2007b. Cash holdings and credit spreads. Working Paper, University of Toronto.

Almeida, H., Campello, M., Weisbach, M. S., 2004. The cash flow sensitivity of cash. Journal of Finance 59 (4), 1777–1804.

Asvanunt, A., Broadie, M., Sundaseran, S., 2007. Growth options and optimal default under liquidity constraints: The role of corporate cash balances. Working Paper, Columbia University GSB.

Bates, T. W., Kahle, K. M., Stulz, R., 2006. Why do U.S. firms hold so much more cash than they used to? NBER, Working Paper 12534.

Berk, J. B., Green, R. C., Naik, V., 1999. Optimal investment, growth options and security returns. Journal of Finance 54 (5), 1553–1607.

Bolton, P., Chen, H., Wang, N., 2009. A unified theory of Tobin's q, corporate investment, financing, and risk management. NBER, Working Paper 14845.

Canova, F., De Nicolo', G., 2003. The equity premium and the risk free rate: A cross country, cross maturity examination. IMF Staff Papers 50 (2), 250–285.

Carhart, M. M., 1997. On persistence of mutual fund performance. Journal of Finance 52 (1), 57–82.

Casella, G., Berger, R. L., 2002. Statistical Inference, 2nd Edition. Duxbury.

Chen, H.-C., Ritter, J., 2000. The seven percent solution. Journal of Finance 55 (3), 1105–1132.

Chocrane, J. H., 2005. Asset Pricing. Princeton University Press, Princeton.

Copeland, T., Lyasoff, A., 2008. The marginal value of retained earnings. Working Paper, MIT and Boston University.

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

Eisfeldt, A. L., Rampini, A. A., 2007. Financing shortfalls and the value of aggregate liquidity. Working Paper, Kellog School of Management, Northwestern University.

Fama, E. F., 1976. Foundations of Finance. Basic Books.

Fama, E. F., French, K. R., 1992. The cross–section of expected stock returns. Journal of Finance 47 (2), 427–465.

Fama, E. F., French, K. R., 1993. Common risk factors in the returns on stocks and bonds. Journal of Finance 33 (1), 3–56.

Faulkender, M., Wang, R., 2006. Corporate financial policy and the value of cash. Journal of Finance 61 (4), 1957–1990.

Froot, K., Scharfstein, D., Stein, J., 1993. Risk management: Coordinating corporate investment and financing policies. Journal of Finance 48 (5), 1629–1658.

Gamba, A., Triantis, A., 2008. The value of financial flexibility. Journal of Finance 63 (5), 2263–2296.

George, T. J., Hwang, C. Y., 2004. The 52–week high and momentum investing. Journal of Finance 69 (5), 2145–2176.

George, T. J., Hwang, C. Y., 2008. A resolution of the distress risk and leverage puzzles in the cross section of stock returns. Working Paper, University of Houston.

Gomes, J., Schmid, L., 2008. Levered returns. Working Paper, The Wharton School, University of Pennsylvania.

Huberman, G., 1984. External financing and liquidity. Journal of Finance 39 (3), 895–908.

Jagannathan, R., Wang, Z., 1998. An aymptotic theory for estimating beta–pricing models using cross–sectional regression. Journal of Finance 53 (4), 1285–1309.

Kan, R., Robotti, C., 2009. A note on the estimation of asset pricing models using simple regression betas. Federal Reserve Bank of Atlanta and University of Toronto.

Kan, R., Robotti, C., Shanken, J., 2008. Two–pass cross–sectional regressions under potentially misspecified models. Working Paper, Goizueta Business School, Emory University.

Kim, C.-S., Mauer, D. C., Sherman, A. E., 1998. The determinants of corporate liquidity: Theory and evidence. Journal of Financial and Quantitative Analysis 33 (3), 335–359.

Livdan, D., Sapriza, H., Zhang, L., 2008. Financially constrained stock returns. Journal of Finance, Forthcoming.

Nikolov, B., 2009. Cash holdings and competition. Working Paper, Swiss Finance Institute and EPFL.

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

Riddick, L. A., Whited, T. M., 2008. The corporate propensity to save. Journal of Finance, forthcoming.

Shanken, J., 1992. On the estimation of beta–pricing models. Review of Financial Studies 5 (1), 1–33.

Simutin, M., 2009. Excess cash holdings, risk, and stock returns. Working Paper, Sauder School of Business, University of British Columbia.

Zhang, L., 2005. The value premium. Journal of Finance 60 (1), 67–103.

A Proofs

A.1 Existence and uniqueness of the optimal savings policy

Proposition A.1 *A unique interior solution to the firm's problem exists if*

$$1 + \pi\lambda\Phi_2|_{S_1=0} > \frac{R}{\widehat{R}}$$

where $\Phi_2 = \Phi(\zeta)$, $\Phi(\cdot)$ *is the cumulative distribution function of a standard normal random variable and*

$$\zeta = \frac{\log(1-S_1) - \mu + .5\sigma_x^2 + \beta_{xm}}{\sigma_x}.$$

Proof: Rewrite the firm's problem as

$$\max_{S_1 \geq 0} C_0 - \frac{S_1}{\widehat{R}} + (1-\pi)E_0\Big[M_1(e^{x_1} + S_1)\Big] + \pi E_0\Big[M_1(1+\lambda\Delta_1)(e^{x_1} + S_1 - 1)\Big] + \pi E_0\Big[M_2 C_2)\Big].$$

Let $\kappa = \log\big(1 - S_1\big)$, then $\pi E_0\Big[M_1(1+\lambda\Delta_1)(e^{x_1} + S_1 - 1)\Big]$ can be rewritten as

$$\pi E_0\Big[M_1(1+\lambda)(e^{x_1} + S_1 - 1)\Big|x_1 < \kappa\Big]\Phi\Big(\frac{\kappa - \mu + 0.5\sigma_x}{\sigma_x}\Big) + \pi E_0\Big[M_1\big(e^{x_1} + S_1 - 1\big)\Big|x_1 \geq \kappa\Big]\Big(1 - \Phi\Big(\frac{\kappa - \mu + 0.5\sigma_x}{\sigma_x}\Big)\Big).$$

The above expression can be further simplified using the following two results.

Lemma A.1 *Let X and Y be two correlated normal random variables. X has mean μ_x and variance σ_x, Y has mean μ_y and variance σ_y. Let ρ be the their correlation coefficient. Then*

$$E\left[e^Y|X \leq \bar{x}\right] = e^{\mu_y+\frac{\sigma_y^2}{2}}\left(\frac{\Phi\left(\frac{\bar{x}-\mu_x}{\sigma_x}-\rho\sigma_y\right)}{\Phi\left(\frac{\bar{x}-\mu_x}{\sigma_x}\right)}\right), \tag{A.1}$$

where Φ is the cumulative distribution function of a standard normal variable.

Lemma A.2 *Let X and Y be two correlated normal random variables. X has mean μ_x and variance σ_x, Y has mean μ_y and variance σ_y. Let σ_{xy} be the their covariance. Then:*

$$E\left[e^X e^Y|X \geq \bar{x}\right] = e^{\mu_y+\mu_x+\frac{\sigma_y^2+\sigma_x^2+2\sigma_{xy}}{2}}\left(\frac{1-\Phi\left(\frac{\bar{x}-\mu_x-\sigma_x^2-\sigma_{xy}}{\sigma_x}\right)}{1-\Phi\left(\frac{\bar{x}-\mu_x}{\sigma_x}\right)}\right); \tag{A.2}$$

where Φ is the cumulative distribution function of a standard normal variable.

These two results can be derived using any standard statistics textbook (e.g. Casella and Berger [2002]).

Using the results in lemma A.1 and A.2, $E_0\Big[M_1\Big(\pi(1+\lambda\Delta_1)(e^{x_1}+S_1-1)\Big)\Big]$ simplifies to

$$\frac{\pi}{R}\Big((1+\Phi_1\lambda)e^{\mu+\beta_{xm}}+(S_1-1)(1+\Phi_2\lambda)\Big),$$

where $\Phi_1 = \Phi\Big(\zeta-\sigma_x\Big)$, $\Phi_2 = \Phi\Big(\zeta\Big)$, and $\zeta = \frac{\kappa-\mu+.5\sigma_x^2+\beta_{xm}}{\sigma_x}$.

The first order condition with respect to S_1 is

$$\frac{1}{\widehat{R}}+\phi = \frac{1-\pi}{R}+\frac{\pi}{R}\left(\frac{e^{\mu+\beta_{xm}}\lambda\Phi'(\zeta-\sigma_x)}{\sigma_x(S_1-1)}+(1+\Phi_2\lambda)+\frac{(S_1-1)\lambda\Phi'(\zeta)}{\sigma_x(S_1-1)}\right),$$

where ϕ is the Lagrange multiplier on the non–negativity constraint for S_1. Now I can exploit the fact that $\Phi'(\zeta-\sigma_x) = \Phi'(\zeta)e^{-0.5\sigma_x^2+\sigma_x\zeta}$ and get the following first order condition

$$\frac{1}{\widehat{R}}+\phi = \frac{1}{R}+\frac{\pi\lambda}{R}\Phi_2.$$

Φ_2 is decreasing in S_1 and converges to 0 as S_1 approaches 1. As a consequence, Φ_2 reaches its maximum value when S_1 is equal to zero. The firm will save a positive amount if and only if $\frac{\pi\lambda}{R}\Phi_2|_{S_1=0} > \frac{1}{\hat{R}} - \frac{1}{R}$, which is equivalent to require $\pi\lambda\Phi_2|_{S_1=0} > \frac{R}{\hat{R}} - 1$. Since Φ_2 is decreasing in S_1 and by assumption $\frac{R}{\hat{R}} > 1$, a unique interior solution exists. ∎

A.2 Optimal savings policy and risk

Proposition A.2 *The optimal savings policy is increasing in the firm's riskiness.*

Proof: Let's consider the first order condition when an interior solution exists and let's evaluate the total differential with respect to S_1^* and σ_{xz}:

$$0 = \left(\frac{\Phi_2'}{\sigma_x(S_1^*-1)}\right)dS_1^* + \left(\frac{\Phi_2'\sigma_z}{\sigma_x}\right)d\sigma_{xz}. \tag{A.3}$$

It follows that

$$\frac{dS_1^*}{d\sigma_{x,z}} = -\frac{\left(\frac{\Phi_2'\sigma_z}{\sigma_x}\right)}{\left(\frac{\Phi_2'}{\sigma_x(S_1^*-1)}\right)} = -\sigma_z(S_1^*-1) > 0, \tag{A.4}$$

since the firm will never choose S_1^* bigger or equal to 1. ∎

A.3 Expected returns and risk

Proposition A.3 *The firm's expected return is increasing in the firm's riskiness if, given the optimal savings policy S_1^*, the following inequality holds:*

$$\sigma_x e^{\mu-\beta_{xm}} \geq \frac{(1+\pi\lambda\Phi_2)}{(1+\pi\lambda\Phi_1)}(1-S_1^*). \tag{A.5}$$

Proof: To asses how a change in riskiness affects expected equity returns, I take the first derivative of

$$E[R_{0,1}^e] = \frac{E_0\Big[(1-\pi)(e^{x_1}+S_1^*)+\pi(1+\lambda\Delta_1)(e^{x_1}+S_1^*-1)\Big]+E_0[\frac{M_2}{M_1}\pi C_2]}{E_0\Big[M_1\Big((1-\pi)(e^{x_1}+S_1^*)+\pi(1+\lambda\Delta_1)(e^{x_1}+S_1^*-1)\Big)\Big]+E_0[M_2\pi C_2]} = \frac{f(\sigma_{xz})}{g(\sigma_{xz})}$$

with respect to σ_{xz}. Applying the quotient rule, $\frac{dE[R_{0,1}^e]}{d\sigma_{xz}} = \frac{g(f_{\sigma_{xz}}-(f/g)g_{\sigma_{xz}})}{g^2}$, where $f_{\sigma_{xz}}$ and $g_{\sigma_{xz}}$ are the derivatives of $f(\sigma_{xz})$ and $g(\sigma_{xz})$ w.r.t. σ_{xz}. The close form expression for the two derivatives are[14]

$$g_{\sigma_{xz}} \quad = \quad \frac{1}{R}\Bigg(- \sigma_x\sigma_z e^{\mu-\beta_{xm}}(1+\pi\lambda\Phi_1) + (1+\pi\lambda\Phi_2)\frac{dS_1^*}{d\sigma_{xz}}\Bigg)$$

and

$$f_{\sigma_{xz}} \quad = \quad (1+\pi\lambda\Phi_4)\frac{dS_1^*}{d\sigma_{xz}},$$

where $\Phi_3 = \Phi\left(\zeta - \frac{\beta xm}{\sigma_x} - \sigma_x\right)$ and $\Phi_4 = \Phi\left(\zeta - \frac{\beta xm}{\sigma_x}\right)$.

Given that $g(\sigma_{xz})$ is positive, a positive change in σ_{xz} will increase expected returns if the following quantity is also positive

$$(1+\pi\lambda\Phi_4)\frac{dS_1^*}{d\sigma_{xz}} - \frac{1}{R}\Bigg(- \sigma_x\sigma_z e^{\mu-\beta_{xm}}(1+\pi\lambda\Phi_1) + (1+\pi\lambda\Phi_2)\frac{dS_1^*}{d\sigma_{xz}}\Bigg)E[R^e_{0,1}].$$

A sufficient condition requires $g_{\sigma_{xz}} < 0$, that is

$$\sigma_x e^{\mu-\beta_{xm}} \quad \geq \quad \frac{(1+\pi\lambda\Phi_2)}{(1+\pi\lambda\Phi_1)}(1-S_1^*),$$

where I used $\frac{dS_1^*}{d\sigma_{xz}} = \sigma_z(1-S_1^*)$. The positive correlation between σ_{xz} and expected returns is a robust result. Figure 12 shows that the sufficient condition ($g_{\sigma_{xz}} < 0$) is satisfied for a wide range of plausible values for σ_x and μ. In particular, the left panel shows that the sufficient condition always holds when $\sigma_x \in [0.2, 1.5]$ and $\lambda = 0.10$, $\pi = 1$, $\sigma_z = 0.4$, and $\mu = 0.4$. The right panel shows that $g_{\sigma_{xz}}$ is always negative when $\mu \in [-1.0, 0.6]$ and $\lambda = 0.10$, $\pi = 1$, $\sigma_z = 0.4$, and $\sigma_x = 1.0$. ∎

A.4 Optimal savings policy: additional properties

Proposition A.4 *The optimal savings policy is:*

- *decreasing in the mean of the cash flow process μ;*
- *decreasing in the risk–free rate R;*
- *increasing in the probability of getting an investment opportunity π;*
- *increasing in the cost of external financing λ.*

[14]In what follows, I use the fact that $\Phi_1' = \Phi(\zeta - \sigma_x)' = \Phi(\zeta)' e^{\log(1-S_1^*)-\mu+\beta_{xm}} = \Phi_2' e^{\log(1-S_1^*)-\mu+\beta_{xm}}$ so that the terms $e^{\mu-\beta_{xm}}\frac{\lambda\Phi_1'}{\sigma_x}\left(\frac{dS_1^*/d\sigma_{xz}}{S_1^*-1} + \sigma_z\right)$ and $(S_1^*-1)\frac{\lambda\Phi_2'}{\sigma_x}\left(\frac{dS_1^*/d\sigma_{xz}}{S_1^*-1} + \sigma_z\right)$ cancel each other.

Proof: Let's consider the first order condition when an interior solution exists and let's evaluate the total differential with respect to S_1^* and μ:

$$0 = \left(\frac{\Phi_2'}{\sigma_x(S_1^* - 1)}\right)dS_1^* + \left(-\frac{\Phi_2'}{\sigma_x}\right)d\mu \Rightarrow \frac{dS_1^*}{d\mu} = -\frac{\left(-\frac{\Phi_2'}{\sigma_x}\right)}{\left(\frac{\Phi_2'}{\sigma_x(S_1^*-1)}\right)} = (S_1^* - 1) < 0.$$

The optimal savings policy is decreasing in the mean of the cash flow process μ since the firm will never choose S_1^* bigger or equal to 1.

The total differential w.r.t. R and S_1^* implies that the optimal savings policy is decreasing in the risk–free rate R:

$$\frac{1}{\widehat{R}}dR = \lambda\pi\left(\frac{\Phi_2'}{\sigma_x(S_1^* - 1)}\right)dS_1^* \Rightarrow \frac{dS_1^*}{dR} = \lambda\pi\frac{\left(\frac{\Phi_2'}{\sigma_x(S_1^*-1)}\right)}{\widehat{R}} < 0.$$

The total differential w.r.t. π and S_1^* implies that the optimal savings policy is increasing in the probability of investing π:

$$0 = \lambda\Phi_2 d\pi + \lambda\pi\left(\frac{\Phi_2'}{\sigma_x(S_1^* - 1)}\right)dS_1^* \Rightarrow \frac{dS_1^*}{d\pi} = -\pi\frac{\left(\frac{\Phi_2'}{\sigma_x(S_1^*-1)}\right)}{\Phi 2} > 0.$$

The total differential w.r.t. λ and S_1^* implies that the optimal savings policy is increasing in the cost of external financing λ:

$$0 = \pi\Phi_2 d\lambda + \lambda\pi\left(\frac{\Phi_2'}{\sigma_x(S_1^* - 1)}\right)dS_1^* \Rightarrow \frac{dS_1^*}{d\lambda} = \lambda\frac{\left(\frac{\Phi_2'}{\sigma_x(S_1^*-1)}\right)}{\Phi 2} > 0. \quad \blacksquare$$

B Data Definitions

Stock prices and quantities are form CRSP. I only consider ordinary common shares (share codes 10 and 11 in CRSP) and I exclude observations relative to suspended, halted, or non–listed shares. I also require that a stock has reported returns for at least 24 months prior to portfolio formation. The monthly risk–free interest rate and the observations relative to the Fama–French factors are taken from Kenneth French's website: *http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/*

The accounting data are from Compustat Annual. I exclude utilities (SIC codes between 4900 and 4949) and financial companies (SIC codes between 6000 and 6999) because these sectors are subject to heavy regulation. I construct the book–to–market ratio following the procedure suggested by Fama and French [1993]. Companies with a negative book–to–market ratio are excluded from the sample. The cash–to–assets ratio is defined as the value of corporate cash holdings (item 1 in Compustat) over the value of the firm's assets (item 6). The book value of leverage at the end of year t – used in the appendix to construct portfolios – is defined as long–term debt (item 9) plus current liabilities (item 34) divided by the firm's total assets (item 6). The last three variables are evaluated using the data available for the fiscal year ending in year $t-1$. The post–ranking market *beta* is constructed following the procedure suggested by Fama and French [1992]. The only difference is that I evaluate the pre–ranking βs using the 24 months prior to portfolio formation for all the stocks.

C Construction of the Cash factor (*HCMLC*)

Following George and Hwang [2008], I form portfolios at a monthly frequency that are held for T months. The overall return of the investment strategy at time t is given by the contributions of the single portfolios formed at time $t-j,\ j=1,...,T$. In order to isolate the contribution of the portfolio formed in month $t-j$, I run the following cross–sectional regression:

$$
\begin{aligned}
R_{it} \quad = \quad & \alpha_{jt} + b_{0,jt}R_{i,t-1} + b_{1,jt}\log(Size_{i,t-1}) + b_{2,jt}\log(BM_{i,t-1}) + b_{3,jt}Loser_{i,t-j} \\
& + b_{4,jt}Winner_{i,t-j} + b_{5,jt}HC_{i,t-j} + b_{6,jt}LC_{i,t-j} + b_{7,jt}HL_{i,t-j} + b_{8,jt}LL_{i,t-j} + \varepsilon_{ijt} \qquad j=1...T.
\end{aligned} \tag{C.1}
$$

The dependent variable is the return to stock i in month t . The independent variables can be separated in two categories. The first one is made up of variables that are known to affect returns. These are the market capitalization of the firm in the previous month ($Size_{i,t-1}$) and the book–to–market ($BM_{i,t-1}$). [15] I also include the previous month return ($R_{i,t-1}$) to control for bid–ask bounce. All the control variables are expressed in deviation from their cross–sectional mean.

The second category is made up of dummies related to portfolio strategies. The first two, *Winner* and *Loser*, are included to control for momentum and are constructed following George

[15] The book–to–market value is the most recent value to date t which has been reported at least 6 months before portfolio formation. This convention is observed for all the accounting variables.

and Hwang [2004].[16] The third and the fourth dummies, $HC_{i,t-j}$ and $LC_{i,t-j}$, indicate portfolio strategies formed on cash holdings. $HC_{i,t-j}$ takes value 1 if stock i was in the top 20% of the cash–to–assets distribution at time $t-j$ and zero otherwise. $LC_{i,t-j}$ takes value 1 if stock i was in the bottom 20% of the cash–to–assets at time $t-j$ and zero otherwise. A similar interpretation holds for $LL_{i,t-j}$ (Low Leverage portfolio) and $HL_{i,t-j}$ (High Leverage portfolio). I add the last two dummies to compare my results with the ones in George and Hwang [2008]. Table XV reports the correlations among the six portfolios described above. It is worth noting that the correlation coefficient between HC and LL is about 0.4: firms that have high cash holdings relative to the value of assets also tend to have low leverage.

The overall contribution of HC portfolios to the total return at time t is given by a simple average over all the $b_{5,jt}$ coefficients, namely $b_{5,t} = \frac{1}{T}\sum_{j=1}^{T} b_{5,jt}$. The average intercept α_t can be interpreted as the excess return of a portfolio that each month hedges the effect on stock returns of all the other independent variables. As a consequence, $\alpha_t + b_{5,t}$ is the return of a strategy that takes each month a long position on the High Cash firms. Finally, $b_{5,t} - b_{6,t}$ is the excess return of a strategy long in the High Cash firms and short in the Low Cash firms.[17]

In Table XVI, the regression coefficients are the time series averages of the monthly contribution from January 1967 to December 2006 and the corresponding t–statistics are evaluated dividing the time series average by their time series standard errors.

In all the regressions, the coefficients on the control variables have the expected sign and are all significant. The coefficients on the portfolios formed on cash–to–assets have signs that agree with the results presented in the previous section: High Cash firms earn a higher average return – 0.42 b.p.m. and equal to the difference between 0.30 and -0.12 – than Low Cash firms after controlling for size and book–to–market. In regression (b), I replicate the analysis in George and Hwang [2008] by looking at portfolios that consider low leverage firms versus high leverage firms. I also find that firms with lower leverage earn a higher average return thus confirming their findings. In the last regression, both the portfolios formed on cash holdings and the portfolios formed on leverage are included. The positive relation between cash holdings and equity returns survives even if I control for the leverage portfolios. In this last case, a strategy long in the High Cash firms and short in

[16] Let $P_{i,t-j}$ the price of stock i at time $t-j$ and $H_{i,t-j}$ the highest price of stock i during the period from $t-j-T$ to $t-j$, I define as *Winner* (*Loser*) at time $t-j$ all the stocks in the top (bottom) 20% of the $\frac{P_{i,t-j}}{H_{i,t-j}}$ distribution.

[17] For a detailed discussion of the parameters' interpretations as returns see chapter 9 in Fama [1976]

the Low Cash firms still yields a considerable excess return of 34 b.p. per month.

The Cash factor ($HCMLC$) is equal to the excess return of a strategy long in the High Cash firms and short in the in the Low Cash firms, namely the difference each month between the coefficients $b_{5,t}$ and $b_{6,t}$ in regression (a) of Table XVI.

Figure 1: **Timing**

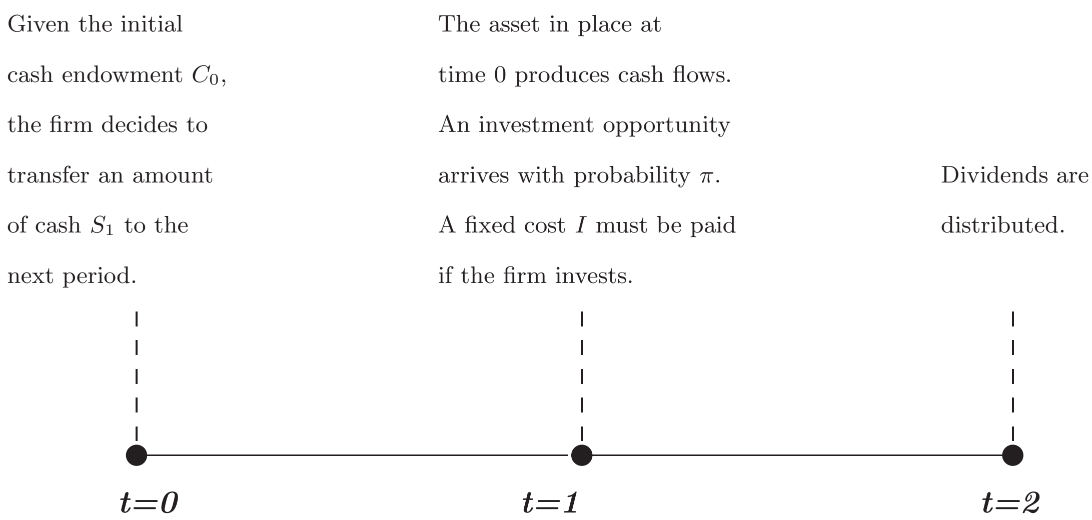


Figure 2: **Euler Equation**

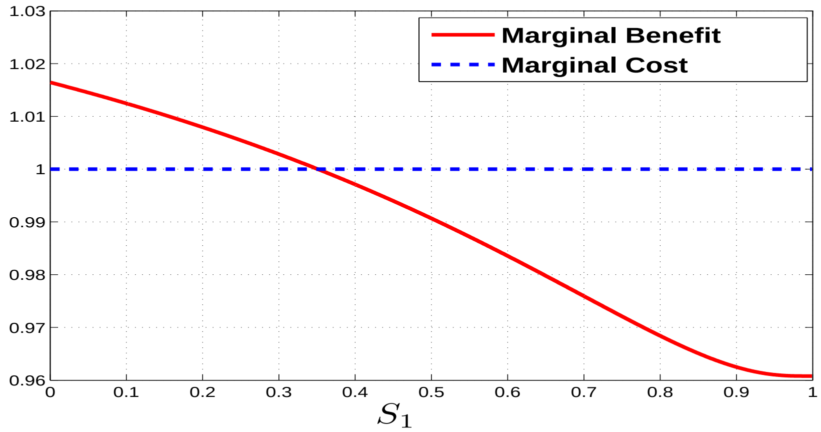


Figure 3: **The effects of varying μ, λ, π, and R**

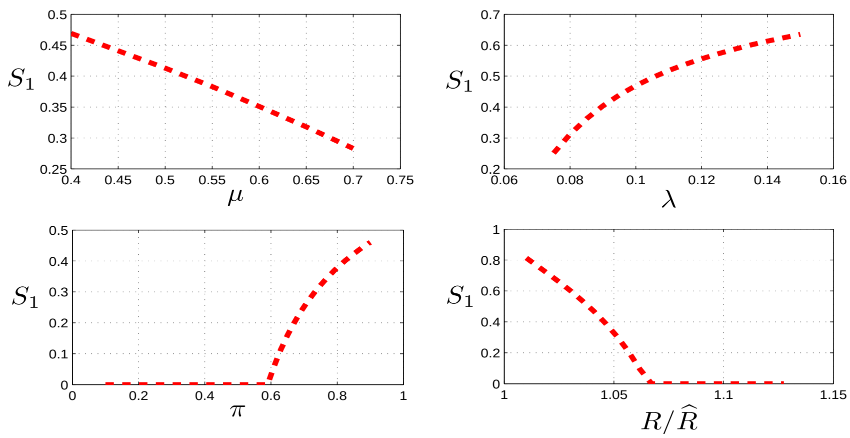


Figure 4: **The Effects of a Change in Risk**

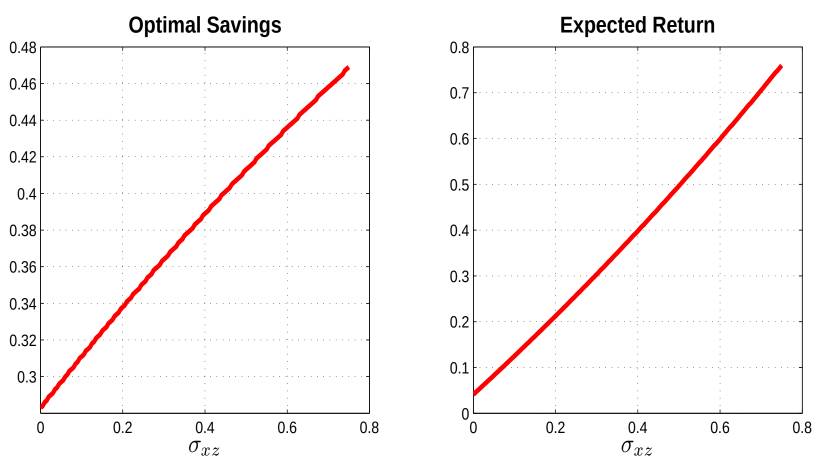
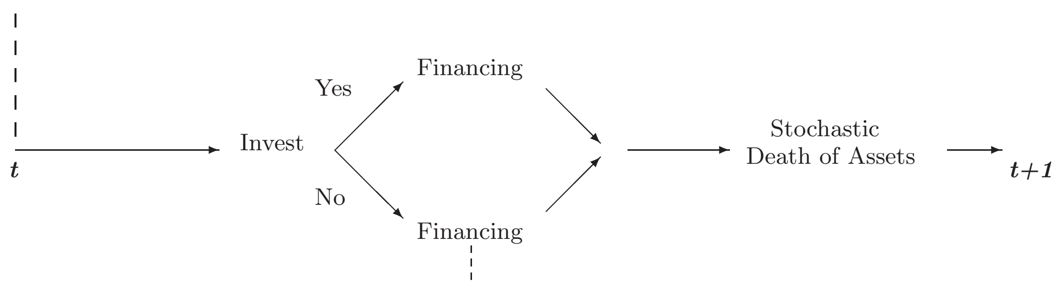


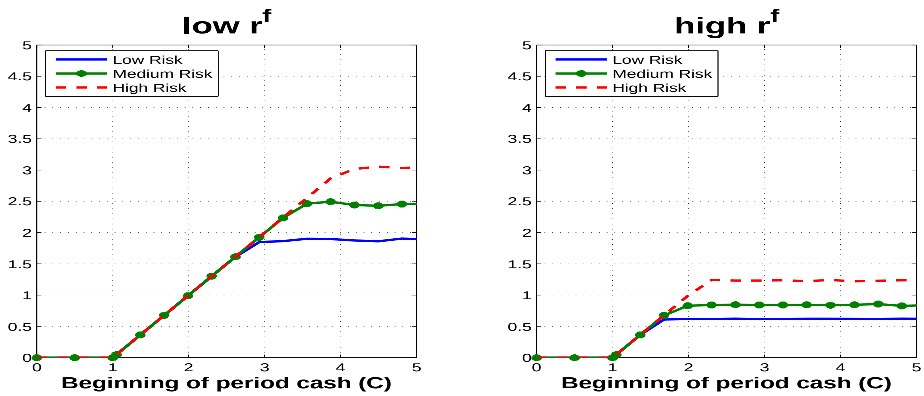
Figure 5: **Timing of the Infinite Horizon Model**

- current risk–free interest rate: r
- Quality of the new investment opportunity: Q={1 if h,0 if l}
- Cash flows and previous period savings
- Assets in place: $n = n_H + n_L$



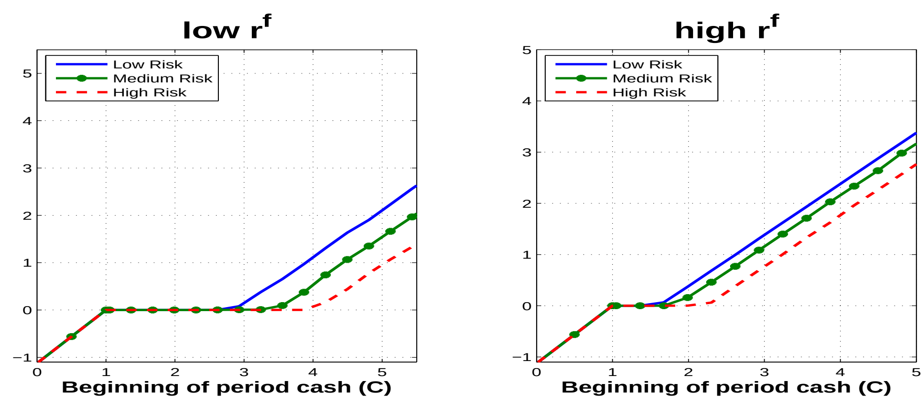
- Equity issuance: D
- Retained Earnings: S'

Figure 6: **Savings**



The left (right) panel of figure 6 depicts the optimal savings policy when the risk–free interest rate is at its lowest (highest) level. Quantities are reported as a function of the beginning of period cash holdings C.

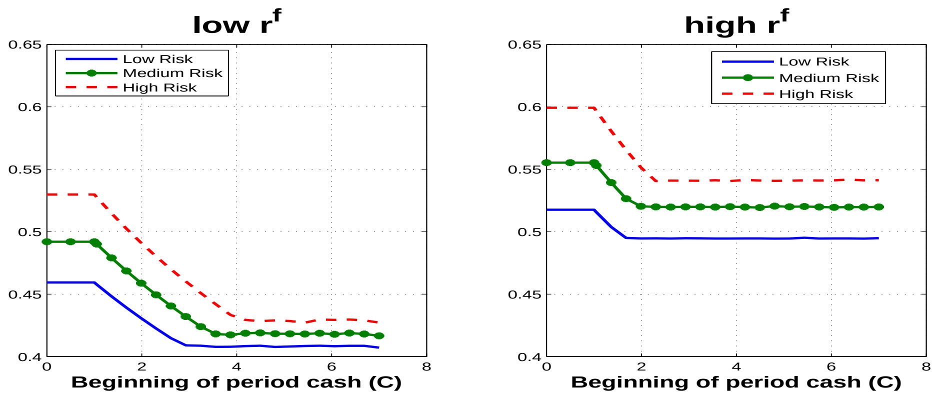
Figure 7: **Dividends**



The left (right) panel of figure 7 depicts the optimal dividend policy when the risk–free interest rate is at its lowest (highest) level. Quantities are reported as a function of the beginning of period cash holdings C.

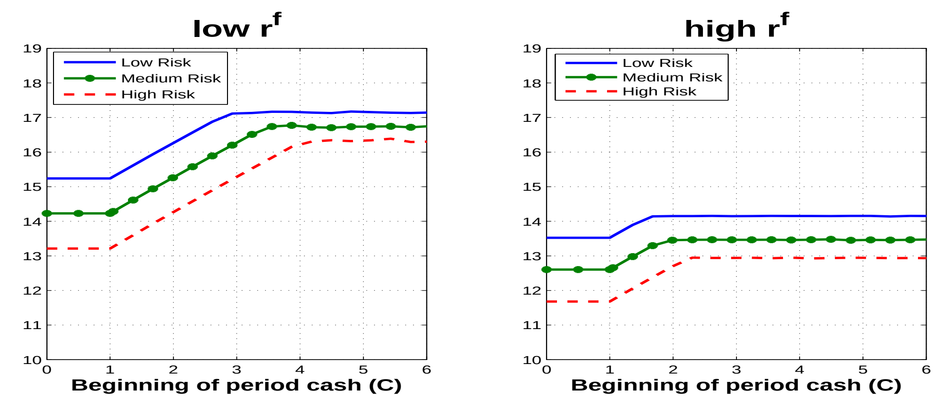
Figure 8: **Book–to–Market**

two



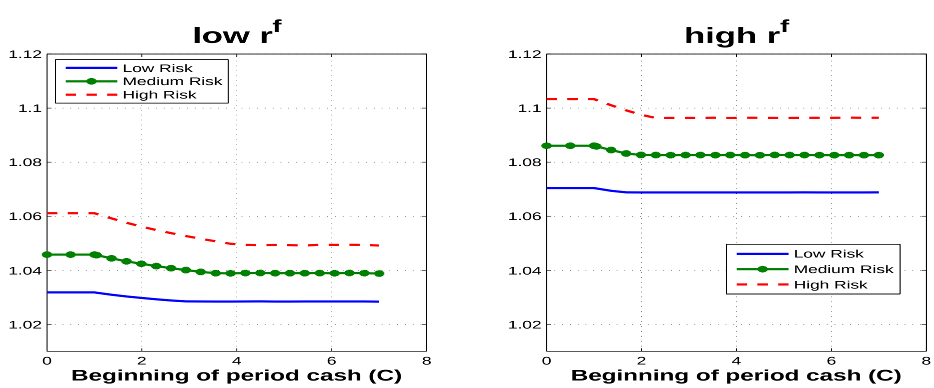
The left (right) panel of figure 8 depicts the book–to–market ratio when the risk–free interest rate is at its lowest (highest) level. Quantities are reported as a function of the beginning of period cash holdings C.

Figure 9: **Ex–Dividend Value**



The left (right) panel of figure 9 depicts the ex–dividend value of equity when the risk–free interest rate is at its lowest (highest) level. Quantities are reported as a function of the beginning of period cash holdings C.

Figure 10: **Expected Equity Returns**



The left (right) panel of figure 9 depicts the expected equity returns when the risk–free interest rate is at its lowest (highest) level. Quantities are reported as a function of the beginning of period cash holdings C.

Figure 11: **Coefficients' sensitivity to β_h**

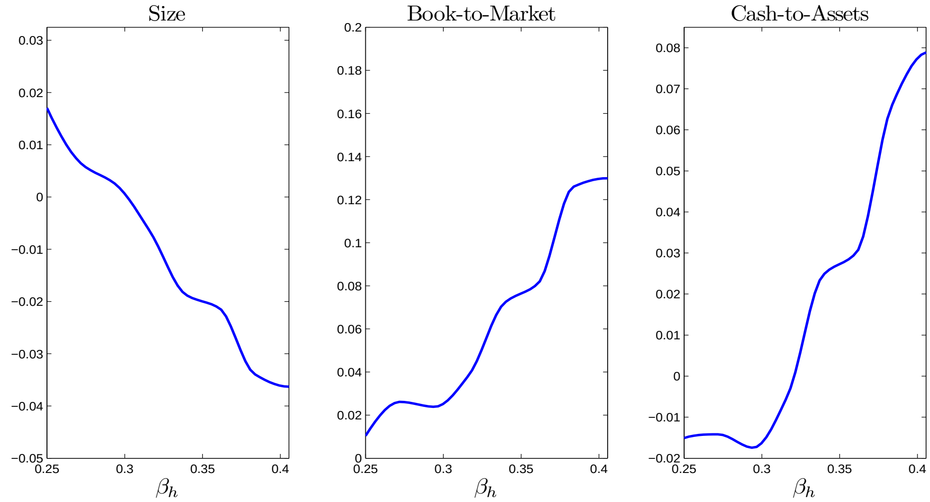


Figure 11 illustrates the coefficients on size, book–to–market and cash–to–assets in equation 5 of table V as a function of β_h, $\beta_h \in [0.25; 0.40]$.

Figure 12: **Sufficient Condition for Positive Correlation**

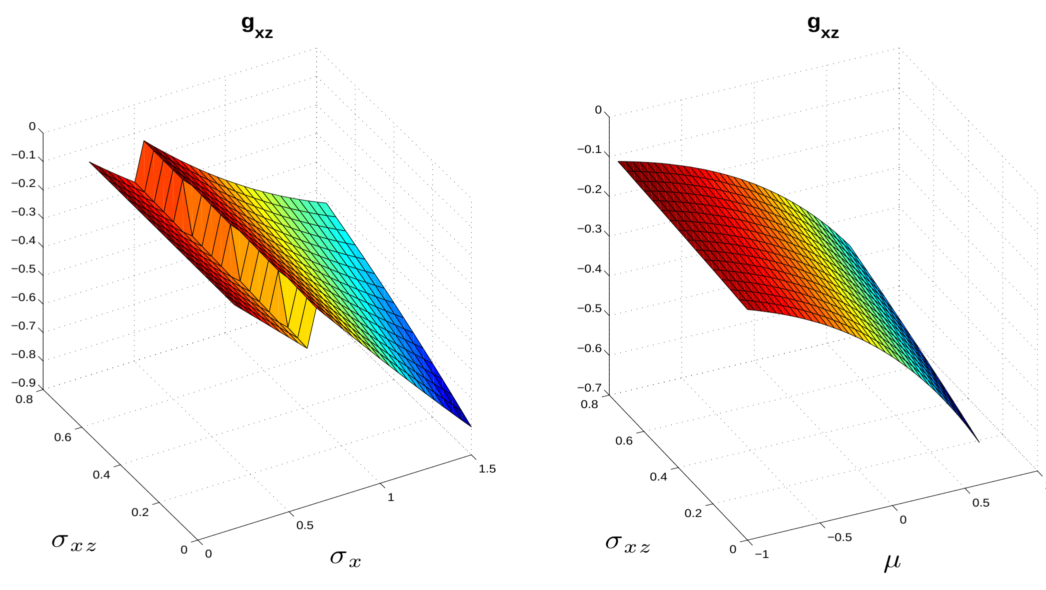


Table I: **Parameters' Values**

A priori information		
Variable	Value	Description
I	1.00	sunk cost for investment
λ	0.10	equity issuance cost
π	0.85	survival probability
τ	0.30	tax on income from interest rates
Interest rate and pricing kernel		
Variable	Value	Description
$\bar{r}$	0.04	unconditional mean of r_{t+1}
ρ	0.75	persistence of r_{t+1}
σ_r	0.02	conditional variance of r_{t+1}
σ_z	0.40	conditional variance of $\log(M_{t+1})$
Technology		
Variable	Value	Description
μ	-0.68	mean of the cash flows distribution
σ_x	1.15	variance of the cash flows distribution
β_h	0.45	correlation asset type h
β_l	0.25	correlation asset type l
θ	0.35	probability of getting a project of type h

Table II: **Sample Moments**

Variable	Description	Data	Model
$E[R^f]$	annual risk–free interest rate	0.018	0.04
$std[R^f]$	std. dev. risk–free interest rate	0.030	0.026
$\rho[R^f]$	autocorrelation risk–free interest rate	0.570	0.610
$\sigma(M)/E(M)$	Sharpe Ratio	0.400	0.431
$E[R - R^f]$	annual equity premium	0.056	0.052
$std[R - R^f]$	std. dev. equity premium	0.168	0.164
$K/(V - D)$	Book–to–market	0.670	0.557
S/K	Savings–to–capital ratio	0.170	0.169
I/K	Investment–to–capital ratio	0.145	0.162

I take the values for the autocorrelation of the annual risk–free interest rate, the average annual equity premium and the corresponding standard deviation from Canova and De Nicolo' [2003]. The investment–to–capital ratio is from Gomes and Schmid [2008]. The values for the unconditional mean and standard deviation of the risk–free interest rate, the average Sharpe Ratio and the book–to–market ratio are from Zhang [2005]. The empirical counterpart of the savings–to–capital ratio can be found in Opler, Pinkowitz, Stulz, and Williamson [1999].

Table III: **Business Cycle Properties**

	Low R^f	High R^f
Book–to–Market	0.52	0.55
Investment–to–Capital	0.18	0.09
Cash–to–Assets	0.16	0.08
Dividends–to–Assets	0.07	0.24
Issuing–to–Assets	0.02	0.01
Investment ratio	1.00	0.35

For each value, I evaluate the time–series average of the cross–sectional mean when the risk–free interest rate takes its lowest and highest value respectively. The numbers reported in the table are the averages over the 500 simulations.

Table IV: **Cross–Sectional Correlations**

	Model			Data		
log *Size*	1.00			1.00		
log *Book–to–market*	0.79	1.00		-0.28**	1.00	
Cash–to–assets	-0.30	-0.67	1.00	-0.03*	-0.22**	1.00

Model: I evaluate the time–series average of the cross–sectional correlation among cash–to–assets, log *book–to–market*, and log *Size*. The numbers reported in the table are the averages over the 500 simulations.
Data: Each year from 1967 to 2006, I calculate the cross–sectional correlations among market capitalization evaluated at June of year t , on book–to–market and on cash–to–assets. The last two variables are evaluated using the data for the fiscal year ending in year $t-1$. The numbers reported in the Table are the time series averages of the cross–sectional correlations. * indicates a significance level of 5%. ** indicates a significance level of 1%. T-statistics are evaluated using the Newey–West methodology. Data definitions are reported in appendix B.

Table V: **Fama–MacBeth Regressions**

	1		2		3		4		5		6	
	model	data	model	data	model	data	model	data	model	data	model	data
β											0.00	-0.25
											(0.25)	*(-0.96)*
log *Size*	-0.01	-0.16			0.02	-0.18			-0.02	-0.15	-0.03	-0.16
	(-2.85)	*(-2.98)*			*(5.29)*	*(-3.78)*			*(-3.83)*	*(-2.88)*	*(-3.81)*	*(-3.43)*
log *Book–to–market*	0.06	0.26					0.06	0.44	0.10	0.29	0.10	0.26
	(5.07)	*(3.15)*					*(4.97)*	*(6.67)*	*(4.65)*	*(4.21)*	*(4.67)*	*(4.34)*
Cash–to–assets			-0.06	0.38	-0.04	0.30	0.03	1.04	0.07	0.79	0.07	0.74
			(-5.46)	*(1.03)*	*(-4.91)*	*(0.84)*	*(2.30)*	*(2.06)*	*(3.65)*	*(2.41)*	*(3.73)*	*(2.49)*

Model: In each period t, realized excess equity returns at time t are regressed on the natural logarithm of the value of the firm at time $t-1$, on the natural logarithm of book–to–market at time $t-1$ and on the ratio of corporate savings over book value of installed assets at time $t-1$. The cross sectional regression is:

$$R_{it} - R^f_{t-1} = \alpha_{t-1} + b_{1,t-1}\beta_{i,t-1} + b_{2,t-1}\log\left(V_{i,t-1} - D_{i,t-1}\right) + b_{3,t-1}\log\left(BM_{i,t-1}\right) + b_{4,t-1}\frac{S_{i,t}/\widehat{R}_{t-1}}{K_{i,t-1} + S_{i,t}/\widehat{R}_{t-1}} + \varepsilon_{i,t}$$

Each reported coefficient is the time series average of the cross-sectional estimates and the corresponding t-statistic is evaluated dividing the time series average by its time series standard errors. The results are generated by the simulation of 500 panels of length 600 each containing 2000 firms. The firm's market beta (β) is evaluated using the previous 24 periods returns.
Data: Staring in July 1967 and ending in June 2007, I regress the realized monthly returns from July of year t to June of year $t+1$ on the post–ranking market *beta* (β), on market capitalization in June of year t ($Size$) and on the relevant accounting variables from the latest fiscal year ending in year $t-1$: book–to–market (BM) and cash–to–assets (CH). The cross sectional regression is

$$R_{it} - R^f_t \quad = \quad \alpha_t + b_{1,t}\beta_{i,t-1} + b_{2,t}\log(Size_{i,t-1}) + b_{3,t}\log(BM_{i,t-1}) + b_{4,t}CH_{i,t-1} + \varepsilon_{i,t}$$

Each coefficient is the time series average of the cross–sectional estimates and the corresponding t-statistics are evaluated dividing the time series averages by their time series standard errors. Accounting data are truncated at the top and bottom 1%. Data definitions are reported in appendix B.

Table VI: **Time Series Regression I**

$$R_i - R^f = \alpha_i + m_i MKT + s_i SMB + h_i HML + t_i MOM + \varepsilon_i$$

Small Size

	α						t(α)						adjusted R^2				
	Cash Holdings						Cash Holdings						Cash Holdings				
	Low	2	3	4	High	HC-LC	Low	2	3	4	High	HC-LC	Low	2	3	4	High
Low	-0.14	-0.02	-0.08	0.18	0.46	0.60	-0.73	-0.10	-0.31	0.81	1.60	2.26	0.77	0.79	0.78	0.81	0.79
2	-0.11	-0.03	0.12	0.38	0.76	0.87	-0.79	-0.23	0.74	2.14	3.00	3.30	0.80	0.82	0.85	0.84	0.80
3	0.11	0.06	0.07	0.34	0.80	0.69	0.93	0.46	0.58	2.05	3.25	2.45	0.81	0.84	0.82	0.85	0.79
4	0.11	0.21	0.28	0.35	0.75	0.64	0.97	1.58	2.42	2.98	3.41	2.73	0.81	0.81	0.85	0.85	0.80
High	0.36	0.16	0.60	0.43	0.70	0.34	2.49	1.22	4.51	3.49	3.54	1.49	0.78	0.79	0.79	0.81	0.80
HB-LB	0.50	0.18	0.68	0.25	0.24		2.93	0.83	3.27	1.27	1.00						

Medium Size

	α						t(α)						adjusted R^2				
	Cash Holdings						Cash Holdings						Cash Holdings				
	Low	2	3	4	High	HC-LC	Low	2	3	4	High	HC-LC	Low	2	3	4	High
Low	-0.35	-0.39	-0.05	0.13	0.27	0.62	-1.82	-2.01	-0.25	0.94	1.15	2.44	0.77	0.80	0.86	0.86	0.80
2	-0.13	-0.27	0.28	0.18	0.48	0.61	-0.94	-1.84	1.69	1.26	2.95	2.53	0.79	0.79	0.83	0.84	0.82
3	-0.09	-0.25	0.10	-0.04	0.30	0.39	-0.79	-1.85	0.74	-0.39	1.86	2.29	0.82	0.76	0.83	0.85	0.82
4	-0.21	-0.13	0.14	0.11	0.41	0.62	-1.97	-1.16	1.43	0.94	3.13	3.61	0.78	0.82	0.82	0.81	0.81
High	-0.11	-0.11	-0.01	0.17	0.17	0.28	-0.87	-0.87	-0.04	1.45	1.09	1.81	0.81	0.80	0.82	0.84	0.81
HB-LB	0.24	0.27	0.04	0.03	-0.10		1.20	1.44	0.22	0.23	-0.50						

Large Size

	α						t(α)						adjusted R^2				
	Cash Holdings						Cash Holdings						Cash Holdings				
	Low	2	3	4	High	HC-LC	Low	2	3	4	High	HC-LC	Low	2	3	4	High
Low	-0.09	0.01	0.32	0.47	0.56	0.65	-0.51	0.05	2.05	2.80	2.74	2.26	0.71	0.77	0.81	0.75	0.77
2	-0.24	0.01	0.20	0.29	0.68	0.92	-1.82	0.04	1.37	1.78	3.01	3.59	0.74	0.75	0.78	0.81	0.73
3	-0.23	-0.25	-0.08	0.21	0.70	0.93	-1.80	-2.08	-0.51	1.64	3.54	4.38	0.77	0.76	0.78	0.81	0.76
4	-0.13	-0.07	-0.16	0.06	0.52	0.65	-1.22	-0.54	-1.27	0.51	2.71	3.30	0.76	0.75	0.76	0.78	0.73
High	-0.01	-0.21	-0.11	0.27	0.26	0.27	-0.10	-1.65	-0.83	1.84	1.47	1.41	0.78	0.74	0.77	0.75	0.75
HB-LB	0.07	-0.22	-0.43	-0.20	-0.31		0.40	-1.21	-2.54	-1.03	-1.86						

In June of year t, stocks are sorted in three size categories (small, medium and large). Within each size category, stocks are sorted in book–to–market quintiles and within each book–to–market quintile stock are further sorted in cash holdings quintiles. This Table reports the intercepts (α), with the corresponding Newey–West t–statistics (t(α)) together with the adjusted R^2 of time series regressions over the 75 portfolios using MKT, SMB, HML and MOM. *HC-LC* is the difference in the intercepts of the firms in the high cash holdings quintile with the firms in the low cash holdings quintile. *HB-LB* is the difference in the intercepts of the firms in the high book–to–market quintile with the firms in the low book–to–market quintile.

Table VII: **Summary statistics of HCMLC, HLMLL, HNMLN, MKT, SMB, HML, and MOM**

	Mean	t-stat	Median	Std. Dev.	Kurtosis	Skewness
HCMLC	0.42	3.22	0.27	2.79	21.13	2.51
MKT	0.49	2.37	0.77	4.51	4.95	-0.50
SMB	0.25	1.63	0.09	3.30	8.54	0.57
HML	0.46	3.37	0.48	3.00	5.38	0.01
MOM	0.81	4.30	0.86	4.10	8.27	-0.63

This table reports the mean with the corresponding Newey–West t–statistics, the median and the standard deviation of the Fama–French three factors (MKT, SMB, HML), of the momentum factor (MOM) and of the Cash factor (HCMLC). The sample period is from July 1967 to June 2007.

Table VIII: **Correlations among Factors**

HCMLC	1.00				
MKT	0.21**	1.00			
SMB	0.32*	0.31**	1.00		
HML	-0.53***	-0.43**	-0.29**	1.00	
MOM	-0.07	-0.08	-0.00	-0.12	1.00

The table reports the correlations among the five factors *HCMLC*, *MKT*, *SMB*, *HML* and *MOM* during the period that starts in June 1967 and ends in December 2006. * indicates a significance level of 5%. ** indicates a significance level of 1%. T-statistics are evaluated using the Newey–West methodology.

Table IX: **HCMLC, Momentum and the Fama–French Factors**

	constant	MKT	SMB	HML	MOM	R-squared
HCMLC	0.71	-0.06	0.16	-0.50	-0.10	0.34
	(4.08)	*(-1.34)*	*(1.58)*	*(-5.29)*	*(-1.15)*	

The table reports the coefficients, the t–statistics and the R–square of a linear regression of the Cash factor on the Momentum and the 3 Fama–French factors. The sample period is from June 1967 to December 2006

Table X: **Time Series Regression II**

$$R_i - R^f = \alpha_i + m_i MKT + s_i SMB + t_i MOM + c_i HCMLC + \varepsilon_i$$

Small Size

	α						t(α)						adjusted R^2				
	Cash Holdings						Cash Holdings						Cash Holdings				
	Low	2	3	4	High	HC-LC	Low	2	3	4	High	HC-LC	Low	2	3	4	High
Low	0.11	0.03	-0.22	-0.12	-0.17	-0.28	0.56	0.16	-0.89	-0.67	-0.88	-1.72	0.77	0.79	0.78	0.83	0.84
2	0.40	0.41	0.31	0.43	0.36	-0.03	2.21	2.28	1.82	2.66	2.18	-0.25	0.82	0.82	0.85	0.84	0.84
3	0.73	0.61	0.66	0.56	0.47	-0.25	4.60	3.78	3.88	3.58	3.47	-2.40	0.84	0.84	0.81	0.84	0.84
4	0.79	0.83	0.84	0.73	0.75	-0.04	5.31	4.70	5.03	4.68	4.86	-0.26	0.81	0.80	0.83	0.83	0.81
High	1.15	0.89	1.30	1.05	0.89	-0.26	6.52	5.37	7.35	6.05	5.14	-1.81	0.77	0.76	0.75	0.76	0.78
HB-LB	1.04	0.86	1.52	1.18	1.06		5.74	3.78	7.82	5.81	4.56						

Medium Size

	α						t(α)						adjusted R^2				
	Cash Holdings						Cash Holdings						Cash Holdings				
	Low	2	3	4	High	HC-LC	Low	2	3	4	High	HC-LC	Low	2	3	4	High
Low	-0.20	-0.50	-0.54	-0.60	-0.77	-0.58	-0.77	-2.34	-3.24	-4.72	-4.49	-2.58	0.79	0.79	0.84	0.85	0.82
2	0.25	0.09	0.35	0.04	-0.09	-0.34	1.44	0.56	1.87	0.29	-0.65	-2.07	0.83	0.82	0.83	0.84	0.84
3	0.37	0.27	0.49	0.19	0.07	-0.30	2.17	1.15	2.73	1.25	0.44	-2.09	0.83	0.77	0.83	0.85	0.83
4	0.49	0.48	0.67	0.53	0.41	-0.08	2.43	2.54	4.53	2.57	2.94	-0.45	0.80	0.81	0.82	0.79	0.81
High	0.63	0.63	0.78	0.66	0.44	-0.19	3.32	2.79	4.01	3.62	2.09	-1.29	0.77	0.77	0.80	0.80	0.78
HB-LB	0.83	1.13	1.31	1.26	1.21		3.78	4.96	5.62	6.44	5.29						

Large Size

	α						t(α)						adjusted R^2				
	Cash Holdings						Cash Holdings						Cash Holdings				
	Low	2	3	4	High	HC-LC	Low	2	3	4	High	HC-LC	Low	2	3	4	High
Low	-0.02	-0.12	-0.25	-0.28	-0.59	-0.57	-0.12	-0.63	-1.81	-1.90	-3.08	-2.48	0.73	0.76	0.77	0.74	0.79
2	0.03	0.21	0.09	-0.02	-0.05	-0.09	0.17	1.30	0.57	-0.15	-0.34	-0.42	0.78	0.78	0.78	0.79	0.77
3	0.15	0.20	0.13	0.19	0.22	0.08	0.87	1.39	0.76	1.72	1.72	0.44	0.79	0.78	0.78	0.81	0.79
4	0.34	0.49	0.43	0.32	0.31	-0.04	2.09	3.06	2.30	2.58	2.23	-0.21	0.76	0.76	0.75	0.78	0.76
High	0.58	0.42	0.58	0.77	0.46	-0.13	3.16	2.64	3.34	4.10	2.51	-0.77	0.77	0.73	0.73	0.72	0.74
HB-LB	0.60	0.54	0.83	1.05	1.05		2.95	2.75	3.39	4.65	4.39						

In June of year t, stocks are sorted in three size categories (small, medium and large). Within each size category, stocks are sorted in book–to–market quintiles and within each book–to–market quintile stock are further sorted in cash holdings quintiles. This Table reports the intercepts (α), with the corresponding Newey–West t–statistics (t(α)) together with the adjusted R^2 of time series regressions over the 75 portfolios using MKT, SMB and $HCMLC$. HC-LC is the difference in the intercepts of the firms in the high cash holdings quintile with the firms in the low cash holdings quintile. HB-LB is the difference in the intercepts of the firms in the high book–to–market quintile with the firms in the low book–to–market quintile. The sample period is from June 1967 to December 2006

Table XI: **Time Series Regression III**

$$R_i - R^f = \alpha_i + m_i MKT + s_i SMB + h_i HML + t_i MOM + c_i HCMLC + \varepsilon_i$$

Small Size

	α						$t(\alpha)$						adjusted R^2				
	Cash Holdings						Cash Holdings						Cash Holdings				
	Low	2	3	4	High	HC-LC	Low	2	3	4	High	HC-LC	Low	2	3	4	High
Low	0.08	-0.05	-0.19	-0.14	-0.17	-0.25	0.40	-0.26	-0.79	-0.75	-0.85	-1.52	0.77	0.79	0.78	0.83	0.84
2	0.22	0.14	0.14	0.23	0.18	-0.04	1.36	1.04	0.83	1.46	1.07	-0.29	0.82	0.82	0.85	0.85	0.85
3	0.50	0.33	0.30	0.22	0.15	-0.35	3.70	2.30	2.43	1.46	1.23	-3.22	0.85	0.86	0.83	0.85	0.85
4	0.42	0.42	0.44	0.33	0.32	-0.10	3.75	2.93	3.57	2.54	2.11	-0.72	0.83	0.82	0.85	0.85	0.83
High	0.67	0.33	0.78	0.51	0.33	-0.33	4.58	2.51	5.59	3.62	2.15	-2.33	0.80	0.80	0.79	0.81	0.82
HB-LB	0.59	0.38	0.97	0.65	0.51		3.54	1.83	5.30	3.75	2.25						

Medium Size

	α						$t(\alpha)$						adjusted R^2				
	Cash Holdings						Cash Holdings						Cash Holdings				
	Low	2	3	4	High	HC-LC	Low	2	3	4	High	HC-LC	Low	2	3	4	High
Low	0.07	-0.20	-0.09	-0.14	-0.29	-0.36	0.34	-0.90	-0.51	-1.15	-1.44	-1.66	0.80	0.80	0.86	0.87	0.84
2	0.28	0.10	0.39	0.09	0.10	-0.18	1.72	0.68	2.29	0.63	0.76	-1.08	0.83	0.82	0.83	0.84	0.84
3	0.16	0.05	0.27	0.04	0.01	-0.15	1.24	0.30	1.73	0.32	0.04	-1.08	0.84	0.78	0.84	0.85	0.83
4	0.15	0.12	0.35	0.20	0.19	0.04	1.17	0.96	3.23	1.49	1.32	0.24	0.82	0.84	0.84	0.81	0.82
High	0.09	0.11	0.26	0.21	-0.01	-0.10	0.61	0.73	1.70	1.50	-0.04	-0.65	0.82	0.81	0.84	0.84	0.81
HB-LB	0.02	0.31	0.34	0.34	0.28		0.09	1.66	1.97	2.62	1.50						

Large Size

	α						$t(\alpha)$						adjusted R^2				
	Cash Holdings						Cash Holdings						Cash Holdings				
	Low	2	3	4	High	HC-LC	Low	2	3	4	High	HC-LC	Low	2	3	4	High
Low	0.26	0.22	0.29	0.17	-0.03	-0.29	1.52	1.12	2.03	1.06	-0.17	-1.31	0.74	0.78	0.81	0.76	0.82
2	0.12	0.27	0.38	0.28	0.19	0.07	0.80	1.68	2.33	1.85	1.08	0.33	0.78	0.78	0.79	0.81	0.78
3	0.08	0.02	0.02	0.21	0.31	0.23	0.54	0.16	0.14	1.74	2.06	1.37	0.80	0.79	0.78	0.81	0.79
4	0.08	0.22	0.07	0.14	0.04	-0.03	0.57	1.84	0.49	1.16	0.27	-0.20	0.78	0.77	0.78	0.78	0.77
High	0.22	0.03	0.07	0.40	-0.02	-0.24	1.78	0.22	0.48	2.47	-0.16	-1.50	0.80	0.76	0.78	0.75	0.77
HB-LB	-0.04	-0.19	-0.22	0.23	0.00		-0.21	-1.05	-1.28	1.27	0.02						

In June of year t, stocks are sorted in three size categories (small, medium and large). Within each size category, stocks are sorted in book–to–market quintiles and within each book–to–market quintile stock are further sorted in cash holdings quintiles. This Table reports the intercepts (α), with the corresponding Newey–West t–statistics ($t(\alpha)$) together with the adjusted R^2 of time series regressions over the 75 portfolios using MKT, SMB, HML, MOM and $HCMLC$. *HC-LC* is the difference in the intercepts of the firms in the high cash holdings quintile with the firms in the low cash holdings quintile. *HB-LB* is the difference in the intercepts of the firms in the high book–to–market quintile with the firms in the low book–to–market quintile. The sample period is from June 1967 to December 2006

Table XII: **Cross–sectional regressions: Price of Covariance Risk (OLS)**

	Intercept	MKT	SMB	HML	MOM	HCMLC	OLS R^2	$R^2 = 1$	$R^2 = 0$
CAPM	1.53	-0.03					0.11	0.00	0.26
	(3.27)	*(-1.45)*					*(0.19)*		
	(2.26)	*(-1.07)*							
CAPM+HML	1.34	-0.02		0.01			0.11	0.00	0.65
	(2.86)	*(-0.76)*		*(0.33)*			*(0.21)*		
	(0.79)	*(-0.24)*		*(0.10)*					
CAPM+HCMLC	3.45	-0.13				0.09	0.51	0.16	0.05
	(7.91)	*(-5.51)*				*(3.55)*	*(0.30)*		
	(4.69)	*(-3.17)*				*(3.41)*			
FF3+MOM	2.35	-0.09	0.05	-0.02	0.02		0.57	0.00	0.20
	(6.11)	*(-3.19)*	*(2.67)*	*(-0.55)*	*(0.64)*		*(0.19)*		
	(3.77)	*(-1.77)*	*(2.51)*	*(-0.32)*	*(0.11)*				
MKT+SMB+MOM+HCMLC	3.23	-0.13	0.04		-0.02	0.07	0.73	0.09	0.02
	(8.12)	*(-5.30)*	*(1.63)*		*(-0.56)*	*(2.70)*	*(0.10)*		
	(6.77)	*(-4.72)*	*(1.21)*		*(-0.32)*	*(2.33)*			
FF3+MOM+HCMLC	2.02	-0.05	0.02	0.11	0.05	0.12	0.84	0.28	0.01
	(5.16)	*(-1.52)*	*(1.03)*	*(3.22)*	*(1.56)*	*(4.08)*	*(0.06)*		
	(5.52)	*(-1.65)*	*(0.82)*	*(2.94)*	*(1.02)*	*(3.42)*			

This table reports the results of the following OLS cross–sectional regressions:

$$E_T(R_t^i - R_t^F) \quad = \quad \gamma_0 + \widehat{\delta}_i \gamma_1 + \nu_i \qquad i = 1 \dots N = 75,$$

where $E_T(R_t^i - R_t^F)$ is a $(N \times 1)$ vector of time series average of the excess returns over the N portfolios, γ_0 is the $(N \times 1)$ constant vector, γ_1 is the $(K \times 1)$ vector of covariance risk premia associated to the estimated $(N \times K)$ covariance matrix between the portfolio's returns and the factors. As a consequence, for each factor there will be 75 covariances instead of 75 regression coefficients (betas). The reported coefficients are the estimated price of covariance risk. The sample period is from June 1967 to December 2006. For each coefficient, the first value in parenthesis is the corresponding t-statistics corrected using the methodology proposed by Shanken [1992]. The second value in parenthesis is the misspecification robust t-statistics evaluated following Kan et al. [2008]. For each of the proposed model, I report the R^2 with the corresponding standard deviation (in parenthesis). In the last two columns, I report the p–values of two tests. The first one tests the hypothesis $R^2 = 1$. This is the specification test proposed by Kan et al. [2008]. If the hypothesis $R^2 = 1$ cannot be rejected, then the model is correctly specified. The second one tests the hypothesis $R^2 = 0$, namely if the proposed model cannot explain any of the variation across the 75 portfolios.

Table XIII: **Cross–sectional regressions: Price of Covariance Risk (GLS)**

	Intercept	MKT	SMB	HML	MOM	HCMLC	GLS R^2	$R^2 = 1$	$R^2 = 0$
CAPM	1.98	-0.06					0.10	0.01	0.00
	(7.62)	*(-3.87)*					*(0.05)*		
	(5.64)	*(-3.30)*							
CAPM+HML	1.87	-0.05		0.02			0.11	0.00	0.00
	(6.48)	*(-2.56)*		*(0.90)*			*(0.05)*		
	(4.41)	*(-1.95)*		*(0.64)*					
CAPM+HCMLC	2.18	-0.08				0.06	0.17	0.01	0.00
	(7.95)	*(-4.53)*				*(2.95)*	*(0.08)*		
	(5.51)	*(-3.38)*				*(2.53)*			
FF3+MOM	1.87	-0.05	0.05	0.04	0.05		0.22	0.03	0.00
	(6.11)	*(-2.27)*	*(3.13)*	*(1.75)*	*(2.42)*		*(0.08)*		
	(5.07)	*(-1.91)*	*(2.85)*	*(1.36)*	*(1.28)*				
MKT+SMB+MOM+HCMLC	2.22	-0.08	0.04		0.04	0.04	0.23	0.03	0.00
	(7.88)	*(-4.43)*	*(2.30)*		*(1.86)*	*(1.99)*	*(0.07)*		
	(6.36)	*(-3.95)*	*(1.67)*		*(1.41)*	*(1.43)*			
FF3+MOM+HCMLC	1.75	-0.03	0.03	0.11	0.07	0.10	0.33	0.08	0.00
	(5.62)	*(-1.43)*	*(1.80)*	*(3.53)*	*(2.86)*	*(3.66)*	*(0.09)*		
	(4.88)	*(-1.25)*	*(1.37)*	*(3.03)*	*(1.91)*	*(2.83)*			

This table reports the results of the following GLS cross–sectional regressions:

$$E_T(R_t^i - R_t^F) \quad = \quad \gamma_0 + \widehat{\delta}_i\gamma_1 + \nu_i \qquad i = 1...N = 75,$$

where $E_T(R_t^i - R_t^F)$ is a $(N \times 1)$ vector of time series average of the excess returns over the N portfolios, γ_0 is the $(N \times 1)$ constant vector, γ_1 is the $(K \times 1)$ vector of covariance risk premia associated to the estimated $(N \times K)$ covariance matrix between the portfolio's returns and the factors. As a consequence, for each factor there will be 75 covariances instead of 75 regression coefficients (betas). The reported coefficients are the estimated price of covariance risk. The sample period is from June 1967 to December 2006. For each coefficient, the first value in parenthesis is the corresponding t-statistics corrected using the methodology proposed by Shanken [1992]. The second value in parenthesis is the misspecification robust t-statistics evaluated following Kan et al. [2008]. For each of the proposed model, I report the R^2 with the corresponding standard deviation (in parenthesis). In the last two columns, I report the p–values of two tests. The first one tests the hypothesis $R^2 = 1$. This is the specification test proposed by Kan et al. [2008]. If the hypothesis $R^2 = 1$ cannot be rejected, then the model is correctly specified. The second one tests the hypothesis $R^2 = 0$, namely if the proposed model cannot explain any of the variation across the 75 portfolios.

Table XIV: **Test of Equality of R^2**

	OLS case				
	CAPM+HML	CAPM+HCMLC	FF3+MOM	MKT+SMB +MOM+HCMLC	FF3+MOM +HCMLC
CAPM	0.00	0.40	0.46	0.63	0.73
	(0.92)	*(0.00)*	*(0.19)*	*(0.04)*	*(0.02)*
CAPM+HML		0.40	0.46	0.62	0.73
		(0.11)	*(0.16)*	*(0.35)*	*(0.01)*
CAPM+HCMLC			0.06	0.23	0.33
			(0.16)	*(0.23)*	*(0.08)*
FF3+MOM				0.17	0.28
				(0.15)	*(0.00)*
MKT+SMB+MOM+HCMLC					0.11
					(0.00)

This table reports the OLS R^2 pairwise differences generated by the six linear factor models together with the corresponding p-value of the test of equality of R^2 (in parenthesis).

	GLS case				
	CAPM+HML	CAPM+HCMLC	FF3+MOM	MKT+SMB +MOM+HCMLC	FF3+MOM +HCMLC
CAPM	0.01	0.06	0.12	0.13	0.22
	(0.52)	*(0.01)*	*(0.05)*	*(0.03)*	*(0.00)*
CAPM+HML		0.06	0.12	0.12	0.22
		(0.00)	*(0.05)*	*(0.00)*	*(0.00)*
CAPM+HCMLC			0.06	0.07	0.16
			(0.00)	*(0.09)*	*(0.01)*
FF3+MOM				0.01	0.10
				(0.37)	*(0.00)*
MKT+SMB+MOM+HCMLC					0.09
					(0.00)

This table reports the GLS R^2 pairwise differences generated by the six linear factor models together with the corresponding p-value of the test of equality of R^2 (in parenthesis).

Table XV: **Correlations among Portfolios**

Winners	1.00					
Losers	-0.24	1.00				
HL	-0.02	0.08	1.00			
LL	0.00	0.01	-0.25	1.00		
HC	-0.01	0.04	-0.16	0.41	1.00	
LC	0.00	0.00	0.15	-0.19	-0.25	1.00

Each month between January 1967 and December 2006, I calculate the correlations among the six portfolios *Winner*, *Loser*, *HL*, *LL*, *HC*, *LC*. The number reported in the table are the time series averages of the cross–sectional correlations.

Table XVI: **Portfolio Analysis: Raw Returns**

	Raw Returns					
	(a)		(b)		(c)	
Intercept	1.05	*(4.20)*	1.10	*(4.35)*	1.09	*(4.31)*
Controls						
R_{t-1}	-0.06	*(-17.26)*	-0.06	*(-17.15)*	-0.07	*(-17.40)*
Size	-0.17	*(-3.79)*	-0.18	*(-3.97)*	-0.17	*(-3.87)*
book–to–market	0.41	*(5.89)*	0.38	*(5.21)*	0.40	*(5.79)*
Portfolios						
Loser	-0.39	*(-2.40)*	-0.35	*(-2.09)*	-0.37	*(-2.30)*
Winner	0.67	*(9.88)*	0.68	*(9.64)*	0.67	*(9.91)*
High Savings (HC)	0.30	*(3.23)*			0.25	*(2.74)*
Low Savings (LC)	-0.12	*(-2.34)*			-0.09	*(-1.82)*
High Leverage (HL)			-0.26	*(-4.13)*	-0.23	*(-3.95)*
Low Leverage (LL)			0.15	*(2.87)*	0.04	*(0.91)*

Each month between January 1967 and December 2006 I estimate a cross–sectional regression where R_{it} is the return in month t to stock i and $R_{i,t-1}$ is the previous month return.

$$\begin{aligned} R_{it} &= \alpha_{jt} + b_{0,jt}R_{i,t-1} + b_{1,jt}\log(Size_{i,t-1}) + b_{2,jt}\log(BM_{i,t-1}) + b_{3,jt}Loser_{i,t-j} + b_{4,jt}Winner_{i,t-j} \\ &\quad + b_{5,jt}HC_{i,t-j} + b_{6,jt}LC_{i,t-j} + b_{7,jt}HL_{i,t-j} + b_{8,jt}LL_{i,t-j} + \varepsilon_{ijt} \qquad j = 1...T \end{aligned}$$

$Size_{i,t-1}$ is the market capitalization of the firm in the previous month and $BM_{i,t-1}$ is the book–to–market. $R_{i,t-1}$, $Size_{i,t-1}$ and $BM_{i,t-1}$ are taken in deviation from the correspondent cross–sectional mean. *Winner* and *Loser* are dummy variables that control for momentum. Let $P_{i,t-j}$ the price of stock i at time $t-j$ and $H_{i,t-j}$ the highest price of stock i during the period from $t-j-T$ to $t-j$, *Winner* (*Loser*) is equal to 1 at time $t-j$ if the stock is in the top (bottom) 20% of the $\frac{P_{i,t-j}}{H_{i,t-j}}$ distribution. $HC_{i,t-j}$ takes value 1 if stock i was in the top 20%of the savings distribution at time $t-j$ and zero otherwise. $LC_{i,t-j}$ takes value 1 if stock i was in the bottom 20%of the savings distribution time $t-j$ and zero otherwise. A similar interpretation holds for $LL_{i,t-j}$ (low leverage) and $HL_{i,t-j}$ (high leverage). The reported coefficients are the time series averages of the cross–sectional averages taken over the $j = 1, ..., 6$ holding periods. The corresponding t–statistics are evaluated dividing the time series average by their time series standard errors as suggested in Fama and MacBeth