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Cash, investments and asset returns

Dayong Huang[a,*], Fang Wang[b]

[a] Department of Accounting and Finance, Bryan School of Business and Economics, UNC Greensboro, Greensboro, NC 27402, United States
[b] Department of Finance and OSC, College of Business, Central Washington University, Ellensburg, WA 98926, United States

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ABSTRACT

We use an investment-based asset pricing model to examine the effect of firms' investments relative to cash holdings on stock returns, assuming holding cash lowers transaction costs. We find that mimicking portfolios based on investments relative to non-cash capital and based on investments relative to cash capital are priced for various testing portfolios. On average, momentum stocks and growth stocks are more sensitive to the factor constructed using investment relative to cash.

1. Introduction

Investment-based asset pricing models that equate stock returns to returns on capital investment have received considerable attention in the finance literature.[1] Given expected future cash flows, investment and future stock returns should negatively co-vary over time because, when future discount rates fall, the hurdle rate on investment falls and firms increase their investments. The implication for cross-sectional asset pricing is that an investment factor emerges. We show that, for cross-sectional asset pricing, stock returns are driven not only by firms' capital investments and future productivity, but also by their decisions in cash holdings.

In our model, firms have three reasons to hold cash and they are all related to transaction costs (Keynes, 1936; Baumol, 1952; Miller and Orr, 1966). First, holding cash avoids the fixed and variable costs (transaction costs) of converting physical assets or other financial assets into cash. This part is related to firms' daily operation and one can view the benefit of having cash as providing a convenience yield. By surveying CFOs of firms, Lins et al. (2008) find that cash is in fact mainly held as a buffer against future cash shortfalls. Second, cash is held to lower future external financing costs (transaction costs) that are related to new projects. If firms expect high future external financing costs, they will have high incentives to hold cash to lower the future transaction costs. In our model, when firms increase their cash holdings today, they may need to issue debt now to finance it, which is costly. Cash is held to balance between today's external financing costs and future's external financing costs.[2] Realistically, when the credit market tightens sharply or a bad productivity shock arrives, external financing costs will rise sharply. As a result, firms with sufficient cash can proceed with profitable projects using their own funds, while other firms that do not have sufficient cash may have to forego those projects (e.g., Fazzari et al., 1988; Kaplan and Zingales, 1997; Campbell et al., 2008).[3] Third, if firms expect a bad productivity shock, they will invest less in physical capital, produce less and allocate more funds to cash. This assumption is consistent with the findings in the theoretical model of Riddick and Whited (forthcoming).

* Corresponding author. Tel.: +1 336 256 0124; fax: +1 336 334 4706.
E-mail addresses: d_huang@uncg.edu (D. Huang), wangf@cwu.edu (F. Wang).

[1] A short list of related studies includes Cochrane (1991, 1996), Restoy and Rockinger (1994), Abel and Eberly (1994), Jermann (1998), Zhang (2005), Balvers and Huang (2007) and Jermann (2008).

[2] Gamba and Triantis (2008) argue that cash holdings provide financial flexibility because, when investment opportunities are poor, between retiring debt and saving cash, firms will save cash. Firms do so because they can avoid the cost of raising the debt back to the same level when investment opportunities emerge. In addition, Bates et al. (forthcoming) find that the average cash to assets ratio was more than doubled, from 10.48% in 1980 to 24.03% in 2004, and that the increase was primarily to save future external financing cost. D'Mello et al. (2008) use the spin-off evidence to show that cash allocation tends to be higher for firms that are smaller, have high research and development expenses, low net working capital and low leverage, therefore they conclude that higher cash ratios are correlated with difficulty of access to external capital and lower internal funds availability.

[3] Haushalter et al. (2007) find that, in a competitive market, firms with higher predation risk (the extent to which a firm shares a proportion of growth opportunities with its rivals) tend to use more derivatives and to keep a larger cash holding.

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We capture the benefit of precautionary savings in our model by allowing current changes (investments) in cash to lower current transaction costs.

Specifically, firms choose physical capital stock as well as cash holdings and finance the deficit using debt.[4] We show that stock return is the weighted average of return on physical capital and return on cash capital. Since the weight on physical capital is significantly larger than that on cash capital, the stock return is largely driven by return on physical capital investment, which is determined by productivity and factors that affect the current shadow price of capital. Thus, in our case, high levels of investment signal low future returns and, if firms do not have sufficient cash, future returns will be even lower. On the other hand, low investment, coupled with sufficient cash in the firm will reinforce future returns. At the cross-sectional level, then, we expect the factor based on investment relative to cash to be a common factor.[5]

Following Fama and French (1996), we then construct portfolios using firms' market capitalization, investment to non-cash capital (I/P ratio) and investment to cash capital (I/C ratio). All stocks are independently divided into three groups based on I/C and into two groups based on size. Our cash investment factor (INVC) is the return difference between the two low I/C portfolios and the two high I/C portfolios. The physical capital investment factor (INVP) is constructed in the same way. Because the cash investment factor (INVC) may share a common trend with the physical capital investment factor (INVP), we regress INVC on INVP to remove the possible trend.[6] We argue that breaking traditional investment factors into physical capital investment and cash capital investment should result in better performance in cross-sectional asset pricing. We expect this improvement because we have a better measurement of q that reflects both investment demand and cash demand. In this respect, our study is complementary to Chen and Zhang (2009); however, we differ from Chen and Zhang in that we model firms' investments in both physical capital and cash capital, we allow interactions between the two types of capitals, and we show that investment relative to cash matters, as do traditional investment factors and expected productivity factors.[7]

We find that a three-factor investment-based model, consisting of the market return, INVP and INVC can explain approximately 67% of the return variations across the 25 size-value portfolios or 25 size-momentum portfolios. The GLS R-squareds are 31% and 22.6% for 25 size-value portfolios and 25 size-momentum portfolios, respectively. The performance of our models is much stronger than those of the CAPM (Sharpe, 1964; Lintner, 1965) and is comparable to those of the Fama–French three-factor model (GLS R-squareds of 32% and 11.1%, respectively). Excluding the market factor does not lower the overall fit of the two investment factors but generates a higher Jensen's α. Another reason that we have market as a factor is because our model is a partial equilibrium model. We do not include profitability factor in our benchmark specification because as documented by Barro (1990), Blanchard et al. (1993) and Chen and Zhang (2009), current and lagged profits are both strongly positively related to current investment. We find that our INVC factor is significantly correlated with the profitability factor with a correlation of -0.39. When a profitability factor measured by current return on assets (Fama and French, 2006; Chen and Zhang, 2009) and a financial constraint factor measured by the Kaplan and Zingales (1997) index are included in the test, our INVP and INVC factors remain significant.

Then we show that growth stocks earn return premiums mainly from the INVC factor, and value stocks earn return premiums mainly from the INVP factor. This finding occurs because growth stocks, on average, have lower I/C ratios, and value stocks have lower I/P ratios. We also find support for momentum stocks' earning their premiums from the INVC factor. Momentum stocks tend to be those with low I/P and I/C ratios; they earn high returns not only because of low investment before the formation of the momentum portfolio, but also because of low investment relative to cash.

Our study sheds light on factor-based cross-sectional asset pricing through the development of a model that performs well and is also theoretically motivated. Classical models such as the CAPM and the consumption-based CAPM are based on appealing intuition and show that stock returns are determined by their covariances with either market returns or marginal utility of consumption (e.g., a stock is risky if it pays highly when marginal utility of wealth/consumption is low, and this kind of stock requires a risk premium). However, the empirical performance of these two models is unimpressive. Fama and French (1996) use market excess return, return spread between small firms and large firms, and return spread between value firms and growth firms as factors in their model and found that these factors explained a substantial portion of cross-sectional stock return variations. However, their model was not derived from firms' optimization or consumers' optimization, and in theory it is not clear why and how expected returns are related to those firm characteristics. Given the magnitude and the importance of this literature, it is surprising that little attention has been given to the idea that the investment relative to cash serves as a common factor. We show that firms' equity returns are driven by their investments in cash capital and physical capital. As shown in Daniel and Titman (1997) and reiterated by Liu et al. (2007), characteristics and covariances are two sides of the same coin and, as a result, investment relative to non-cash capital and investment relative to cash capital act as common factors.

The next section of this paper describes the model. In Section 3, we report our pricing results for our three-factor model using various testing portfolios and estimation methods. Section 4 concludes.

2. A model of cash holdings

To motivate our empirical work, we consider a discrete time, infinite horizon, partial equilibrium model of physical capital investment and cash holding (e.g., Cochrane, 1991, 1996; Restoy and Rockinger, 1994; Zhang, 2005; Riddick and Whited, forthcoming; Lin, 2008; Xing, 2008). First, we describe firms' optimization problem and financing. Then we show how stock return relates to those optimal choices, particularly, cash holdings.

2.1. Firm's problem

Firms use a single input, physical capital k_t^p, to produce output at time t. The level of productivity is measured as Θ_t and the profit function is $\pi(k_t^p, \Theta_t)$, where we assume constant elasticity of substitution (CES), i.e. it is $\Theta_t k_t^p$.

When firms invest in physical capital, they need to pay the traditional convex adjustment cost, $\Phi(i_t^p, k_t^p)$, which includes relevant expenses for installing new machines and expenses associated

[4] For simplicity and tractability, we do not consider other factors such as corporate tax, personal tax, information asymmetry and agency costs.

[5] In general, the investment-cash flow literature has examined how investment responds to cash flows (Kaplan and Zingales, 1997; Hubbard, 1998; Cleary, 1999; Almeida et al., 2004; Moyen, 2004; Guariglia, 2008; Brown and Petersen, 2009). Our approach differs in that we examine how stock returns respond to such decisions in a neoclassical model.

[6] The correlation between original INVP and INVC is -0.28. Using INVP and INVC generates similar results for cross-sectional testing.

[7] Li et al. (2006) demonstrate that an extended version of the Cochrane (1996) model with four investment growth factors accounts for the Fama–French 25 size and book-to-market portfolios.

with learning by doing (Hayashi, 1982; Abel and Eberly, 1994). The adjustment cost is positively related to current physical capital investment i_t^p and negatively related to physical capital stock k_t^p.[8] In addition, firms need to pay another adjustment cost which we refer as the transaction cost, $T(i_t^p, k_t^c + i_t^c)$, where k_t^c and i_t^c are cash capital stock and cash capital investment. We assume the following properties for T: T is homogeneous and $T_1 > 0, T_{11} > 0$, $T_2 < 0, T_{22} > 0, T_{12} < 0$.[9] T differs from the traditional adjustment cost $\Phi(i_t^p, k_t^p)$ in that it is an adjustment cost related to cash. Cash holdings allow firms to avoid converting financial or real assets into cash for daily operations, thus provide a convenience yield and lower transaction costs. We assume that current cash investment, i_t^c, does not take time to adjust and it will lower current transaction costs. This approach of modeling captures the benefits that firms get when they allocate more funds to cash if they anticipate a negative productivity shock (Riddick and Whited, forthcoming). It also allows current decision on cash investment to be able to have an effect on the current return on physical capital investment.[10]

Both physical capital and cash capital accumulate through

$$k_{t+1}^j = (1 - \delta_j)k_t^j + i_t^j \quad j = p, c \tag{1}$$

where again i_t^p is investment in physical capital, i_t^c is investment in cash, k_t^p and k_t^c are stocks of physical capital and cash capital, respectively, δ_p is the depreciation rate of physical capital, and δ_c is the inflation rate.

External financing takes the form of debt. It may be risky, long-term debt, commercial paper (Kahl et al., 2008) or lines of credit (Lins et al., 2008). This simplification allows us to focus on the choices between cash and debt. In fact, whether a firm finances with equity or debt should not affect our qualitative results because both types of financing are costly and differ only in magnitude.[11] Accordingly, we define debt issuance as

$$b_t = i_t^p + \Phi(i_t^p, k_t^p) + T(i_t^p, k_t^c + i_t^c) + i_t^c - \Theta_t k_t^p \tag{2}$$

If $b_t > 0$, firms are issuing debt, and if $b_t < 0$, firms are making distributions to debt-holders. The external financing cost function is $\mathbb{1}_b\lambda(b_t)$, where $\mathbb{1}_b$ is an indicator that equals one if $b_t > 0$ and zero if $b_t < 0$. In order to relate stock returns to characteristics and for simplicity, we assume $\lambda(b_t)$ equal to $[h_0 - h_1\Theta_t]b_t$, where h_0 and h_1 are positive parameters. The multiplicative term $[h_0 - h_1\Theta_t]$ can be viewed as the price of debt and it is counter-cyclical. Everything else constant, firms with worse productivity shocks are more likely to be financially constrained and λ for those firms will be higher.[12] In our model, firms are price-takers and the financial constraints for all firms are determined endogenously once the productivity shocks are realized, but our approach has a disadvantage compared to that of Livdan et al. (forthcoming), where collateral constraints on the amount of debt firms can borrow are used explicitly as the cause for financial constraints in a simulated economy.

Our time horizon goes from today, time t to infinite future. Thus for each period $t+s$, where s goes from zero to infinity, firms' profit is $\pi(k_{t+s}^p, \Theta_{t+s})$, and they will choose physical capital investment, i_{t+s}^p, and cash investments, i_{t+s}^c, pay traditional adjustment costs, $\Phi(i_{t+s}^p, k_{t+s}^p)$, and cash adjustment costs, $T(i_{t+s}^p, k_{t+s}^c + i_{t+s}^c)$, and pay external financing cost of $\lambda(b_{t+s})$ for b_{t+s} amount of debt. Firms' goal is to maximize current and expected discounted future cash-flows, modeled as follows:

$$\begin{aligned} V_t = Max_{(i_{t+s}^p, i_{t+s}^c)_{s=0,\infty}}\ & E_t M_{t+s}\{\Theta_{t+s}k_{t+s}^p - i_{t+s}^p - \Phi(i_{t+s}^p, k_{t+s}^p) \\ & - T(i_{t+s}^p, k_{t+s}^c + i_{t+s}^c) - i_{t+s}^c - \mathbb{1}_b\lambda(b_{t+s})\} \end{aligned} \tag{3}$$

subject to Eq. (1). M_{t+s} is the discount factor for different periods. Extending Eq. (3) allows us to focus on terms that are relevant for i_t^p and i_t^c, and we have

$$\begin{aligned} V_t = Max_{(i_{t+s}^p, i_{t+s}^c)_{s=0,\infty}}\ & \pi(k_t^p, \Theta_t) - i_t^p - \Phi(i_t^p, k_t^p) \\ & - T(i_t^p, k_t^c + i_t^c) - i_t^c - \mathbb{1}_b\lambda(b_t) + E_t M_{t+1}\{[\pi(k_{t+1}^p, \Theta_{t+1}) \\ & - i_{t+1}^p - \Phi(i_{t+1}^p, k_{t+1}^p) - T(i_{t+1}^p, k_{t+1}^c + i_{t+1}^c) - i_{t+1}^c - \mathbb{1}_b\lambda(b_{t+1})\} \\ & + \ldots \end{aligned} \tag{4}$$

subject to Eq. (1), and M_t is normalized to one.

2.2. Optimal policies

If we let q_t^p and q_t^c be the shadow value of physical capital and cash capital at time t, we obtain the following first-order conditions:

$$\begin{aligned} q_t^p &= [1 + \mathbb{1}_b\lambda_1(b_t)][1 + \Phi_1 + T_1] \\ &= E_t M_{t+1}\{[1 + \mathbb{1}_b\lambda_1(b_{t+1})][\Theta_{t+1} - \Phi_2] + q_{t+1}^p(1 - \delta_p)\} \end{aligned} \tag{5}$$

$$\begin{aligned} q_t^c &= [1 + \mathbb{1}_b\lambda_1(b_t)][1 + T_2] \\ &= E_t M_{t+1}\{[1 + \mathbb{1}_b\lambda_1(b_{t+1})][-T_2] + q_{t+1}^c(1 - \delta_c)\} \end{aligned} \tag{6}$$

where subscripts are first-order derivatives and we omit the terms for each variable for notational simplicity.

The left-hand side of Eq. (5) is the cost of investing an additional unit of physical capital, which includes $1 + \Phi_1 + T_1$ and $\mathbb{1}_b\lambda_1[1 + \Phi_1 + T_1]$. The term $1 + \Phi_1 + T_1$ shows that when firms invest in physical capital, they need to pay not only the price of the physical capital which is normalized to one, but also the marginal adjustment cost, Φ_1, which is related to physical capital, and the marginal transaction costs, T_1, which is related to the cash capital. Since this investment may increase the debt level by $1 + \Phi_1 + T_1$, the additional cost of investing in physical assets includes $1 + \Phi_1 + T_1$ multiplied by the marginal external financing costs, $\mathbb{1}_b\lambda_1$. The right-hand side of Eq. (5) is the expected discounted future marginal benefits. The term, $q_{t+1}^p(1 - \delta_p)$, is the residual value of the invested physical capital and the term, $\Theta_{t+1} - \Phi_2$, is the marginal product $\pi_1(k_{t+1}^p, \Theta_{t+1})$ plus the savings on adjustment cost. This latter term also represents possible reduction in the demand for debt at time $t+1$, thus part of the benefit of investing in physical assets is from savings on external financing costs at time $t+1$, which is captured by $\mathbb{1}_b\lambda_1(b_{t+1})[\Theta_{t+1} - \Phi_2]$.

Similarly, the left-hand side of Eq. (6) shows that the shadow price of cash includes $1 + T_2$ and $\mathbb{1}_b\lambda_1[1 + T_2]$. The first term, $1 + T_2$, is the price of one unit of cash capital which is normalized to one, minus the convenience yield, $-T_2$. This convenience yield is due to the fact that cash smoothes operations and firms allocate more funds to cash when future prospects are dim. $1 + T_2$ is also the extra amount of debt that firms may need to raise through debt. Multiplying the extra debt needed by $\mathbb{1}_b\lambda_1$, the marginal external financing cost, gives us the second term, the additional cost of holding an extra unit of cash. Firms hold cash to the point where the cost does not exceed the expected discounted future benefits, which include the residual value of invested cash, $q_{t+1}^c(1 - \delta_c)$, convenience yield at time $t+1, -T_2$, and savings on external financing cost at time $t+1$, $[\mathbb{1}_b\lambda_1(b_{t+1})][-T_2]$. Note that

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[8] The usual adjustment cost function takes the form of $\frac{a_1}{2}\left(\frac{i_t^p}{k_t^p}\right)^2 k_t^p$ where a_1 is a positive parameter.

[9] Specifically, T can take the following functional form: $T_t = \frac{a_2}{2}\left(\frac{i_t^p}{k_t^c + i_t^c}\right)^2 (k_t^c + i_t^c)$ and a_2 is a positive parameter.

[10] Huberman (1984) requires firms to hold cash before new projects were undertaken. Kim et al. (1998) use a three-period model to show firms' investments in cash are positively related to the cost of external financing. Other dominant explanations for cash holdings include information asymmetry, agency costs and financial hierarchy. See Opler et al. (1999).

[11] For simplicity, we do not consider the cost of external financing to be the outcome of an asymmetric information problem.

[12] In Kaplan and Zingales (1997), financial constraint is simply modeled as a parameter on the traditional adjustment cost function. Assuming $\lambda(b_t) = \frac{h_2}{2}b_t^2$, where h_2 is a positive parameter, gives qualitatively similar results because b_t is negatively related to Θ_t.

without debt financing, the effective price of investing in cash at time t is $1 - T_2$.

2.3. Investment return and stock return

We define returns on the two capitals as:

$$r^p_{t+1} = \frac{(1 + \mathbb{1}_b\lambda_1)(\Theta_{t+1} - \Phi_2) + q^p_{t+1}(1 - \delta_p)}{q^p_t} \tag{7}$$

$$r^c_{t+1} = \frac{-T_2(1 + \mathbb{1}_b\lambda_1) + q^c_{t+1}(1 - \delta_c)}{q^c_t} \tag{8}$$

Using this definition and Eqs. (5) and (6) we get the standard asset pricing equations for physical capital investment return and cash capital investment return:

$$E_t[M_{t+1}r^p_{t+1}] = 1 \tag{9}$$

$$E_t[M_{t+1}r^c_{t+1}] = 1 \tag{10}$$

We show in Appendix A that the ex-dividend stock price today is:

$$p_t = q^p_t k^p_{t+1} + q^c_t k^c_{t+1} \tag{11}$$

The market value of a firm consists of the market value of physical capital and the market value of cash capital.[13] In Appendix A, we also show that the cum-dividend stock return is a weighted average of return on physical capital investment and return on cash capital investment:

$$r_{t+1} = r^p_{t+1}\frac{q^p_t k^p_{t+1}}{p_t} + r^c_{t+1}\frac{q^c_t k^c_{t+1}}{p_t} \tag{12}$$

Thus, from Eqs. (9)–(12) we have

$$E_t[M_{t+1}r_{t+1}] = 1 \tag{13}$$

where r_{t+1} can act as the common factor according to Cochrane (1996). Eqs. (7) and (8) show that, return on physical capital investment, r^p_{t+1}, is determined by $\Theta_{t+1}, \Phi_2, q^p_{t+1}$ and q^p_t, and return on cash capital investment, r^c_{t+1}, is determined by $\Theta_{t+1}, T_2, q^c_{t+1}$ and q^c_t. Eq. (12) shows that the weights are determined by q^p_t, q^c_t, k^p_{t+1} and k^c_{t+1}. We can rewrite Eq. (12) in a more generalized form

$$\begin{aligned} r_{t+1} &= F\left(\Theta_t, k^p_t, k^c_t, \frac{i^p_t}{k^p_t}, \frac{i^p_t}{k^c_t + i^c_t}, \frac{i^p_{t+1}}{k^p_{t+1}}, \frac{i^p_{t+1}}{k^c_{t+1} + i^c_{t+1}}, \Theta_{t+1}, k^p_{t+1}, k^c_{t+1}\right) \\ &= \overline{F}\left(\Theta_t, k^p_t, k^c_t, \frac{i^p_t}{k^p_t}, \frac{i^p_t}{k^c_t + i^c_t}, \Theta_{t+1}, k^p_{t+1}, k^c_{t+1}\right) \\ &= \widetilde{F}\left(\Theta_t, k^p_t, k^c_t, \frac{i^p_t}{k^p_t}, \frac{i^p_t}{k^c_t + i^c_t}, \epsilon_{t+1}\right) \end{aligned} \tag{14}$$

where the first equality uses the fact that qs are functions of $\frac{i^p}{k^p}$ and $\frac{i^p}{k^c+i^c}$, and k^p_{t+1} and k^c_{t+1} are functions of $\frac{i^p}{k^p}$ and $\frac{i^c_t}{k^c_t}$, respectively.[14] To get the second equality we use the fact that all investments at time $t+1$, i^p_{t+1} and i^c_{t+1} are functions of time $t+1$ state variables, which are Θ_{t+1}, k^p_{t+1} and k^c_{t+1}. And to get the third equation, we treat ϵ_{t+1} as the productivity shock. The state of the economy, Θ_t, k^p_t, and k^c_t may serve as conditioning variables (Cochrane, 2001), but we do not consider them because Lewellen and Nagel (2006)show that conditioning variables barely improve the performance of asset models. This approach allows us to rewrite Eq. (14) in the following reduced form for each asset i

$$r^i_{t+1} = \widehat{F}\left(\epsilon_{t+1}, \frac{i^p_t}{k^p_t}, \frac{i^p_t}{k^c_t + i^c_t}\right) \tag{15}$$

Eq. (15) shows theoretically why returns or expected returns are related to certain characteristics, which are productivity/profitability, I/P and I/C in our model, and allows us to construct common factors using those characteristics.[15] The common factors are then the productivity factor, INVP factor and INVC factor. In our benchmark specification we include the market return as a factor because the model is a partial equilibrium model and exclude the profitability factor because as suggested by Barro (1990), Blanchard et al. (1993) and Chen and Zhang (2009), current and lagged profits are both strongly positively related to current investment. We find that our INVC factor is significantly correlated with the profitability factor with a correlation of -0.39.[16] Thus, we end up with a theoretically motivated parsimonious three-factor investment-based model, consisting of the market return, INVP and INVC as our benchmark model. The model is

$$E[R^i] = \beta_{im}E[MKT] + \beta_{ip}E[INVP] + \beta_{ic}E[INVC] \tag{16}$$

where $E[R^i]$ is the expected excess return of stock i; E[MKT] is the expected premiums on market excess return; E[INVP] and E[INVC] are expected premiums on factors constructed using firm level I/P ratio and I/C ratio, respectively; and β_{im}, β_{ip} and β_{ic} are factor loadings estimated from the following time series regression:

$$R^i_{t+1} = \alpha_i + \beta_{im}MKT_{t+1} + \beta_{ip}INVP_{t+1} + \beta_{ic}INVC_{t+1} + \eta_{i,t+1} \tag{17}$$

where α_i are constants and $\eta_{i,t+1}$ are errors in the first-pass regression for each portfolio. Since INVP, INVC may not capture all the variations in the productivity factor and financial constraints factor, we also test multi-factor models in which proxies for future productivity and financial constraints are added. We also exclude the market return to show the robustness of the factors based on investments relative to physical capital and investments relative to cash.

3. Empirical results

3.1. Data

We obtain monthly stock returns from January 1964 to December 2006 from CRSP, and the annual characteristics data from COMPUSTAT. Physical capital investment is defined as the annual change in fixed assets and inventories, and cash capital investment is defined as the annual change in cash for firms in COMPUSTAT.[17]

[13] Faulkender and Wang (2006) find that the market value of cash is contingent upon whether the cash is used to pay dividends, to service debt or to decrease the amount that is needed in the credit market. They found that the marginal value of cash declines with larger cash holdings, higher leverage, and better access to capital markets, and that it also declines as firms choose greater cash distributions via dividends, rather than repurchases. Pinkowitz and Williamson (2007) also estimate the market value of corporate cash. They find the value of cash is affected by both the investment and financing opportunity sets. Specifically, cash is more valuable for firms with better growth options, more volatile investment opportunities, poorer access to capital, and lower probability of financial stress.

[14] Note that using $\frac{i^p_t}{k^c_t+i^c_t}$ is similar to use $\frac{i^c_t}{k^c_t}$ since we can write $\frac{i^p_t}{k^c_t+i^c_t} = H(\Theta_t, k^p_t, k^c_t, \frac{i^c_t}{k^c_t})$, where H is a general function because i^p_t is a function of the first three elements in function H and $k^c_t + i^c_t$ is function of k^c_t and $\frac{i^c_t}{k^c_t}$.

[15] When developing the sorting criteria, Chen and Zhang (2009) have only time t variables and expected future productivity because they used a two-period model, in which there are no investment decisions in the second period.

[16] The widely cited Fama and French (1992, 1993, 1996) three-factor model also has a market factor; our model is similar in that it is a characteristics-based model.

[17] Cash (Compustat item #1) includes bank drafts, cash, checks (cashiers or certified), demand certificates of deposit, demand deposits, letters of credit, money orders, government and other marketable securities and time deposits. Firm size is measured by stock price times the total shares outstanding. The book-to-market equity ratio (BE/ME) at time t is calculated by dividing book equity (BE) at the fiscal end of year $t-1$ by market equity (ME) in December of year $t-1$. There is a lag of at least 6 months between accounting data and market data. Following Cohen et al. (2003) and Fama and French (2008), we define book equity as the stockholders' equity, plus balance sheet deferred taxes (Compustat item #74) and investment tax credit (Compustat item #208), plus post-retirement benefit liabilities (Compustat item #330), less the book value of preferred stock. Depending on availability, we measure the book value of preferred stock by the order of redemption (Compustat item #56), liquidation (Compustat item #10), or par value (Compustat item #130). Stockholders' equity is measured by Compustat item #216 or the book value of common equity (Compustat item #60), plus the par value of preferred stock or the book value of assets (Compustat item #6), less total liabilities (Compustat item #181).

Only firms with ordinary common equity classified by CRSP are included in the test and financial firms are excluded.

To construct INVC, we independently sort firms by size and investment-to-cash assets (I/C). We use the 50% size breakpoints for NYSE stocks to split all stocks into two groups in June of each year t; following Fama and French (1996), we also split all stocks into three I/C groups based on the 30% and 70% breakpoints for NYSE stocks. We then form six portfolios from the intersection of the two size groups and the three I/C groups, compute monthly returns for all portfolios from July of year t to June of year $t+1$, and rebalance the portfolios in June of year $t+1$. The INVC is the difference between the average return of two low-I/C portfolios and two high-I/C portfolios. INVP is constructed in a similar way using investments relative to physical capital (I/P). We regress INVC on INVP to remove the trending component in INVC that is due to INVP and used the residual for further study.

For later comparison, we apply similar approach to construct factors INVA, ROA and FINC, which are based on I/A (investment divided by total assets), return on assets and the KZ index that captures financial constraints.[18] Our main testing assets are 25 size- and value-sorted portfolios, 30 industrial portfolios and 25 momentum portfolios. The Fama–French three factors and the momentum factor are obtained from French's website.[19]

3.2. Portfolio return formed on I/P and I/C

Panels A and B of Table 1 report descriptive statistics. INVP has a mean of 0.26%, which is negatively correlated with market excess return, and this suggests that firms invest more when the future discount rate is low. The negative relationship between INVP and SMB suggests that small firms require the future discount rate to be even lower before they invest, while the positive relationship between INVP and HML signals a similar situation for growth firms. On the other hand, INVC is negatively related to HML and positively related to market excess return, SMB and the momentum factor. A high level of cash increases return on physical capital through reduced transaction costs, which is more likely to happen among small stocks, growth stocks and momentum stocks[20]

Panel C of Table 1 reports the average excess returns of six portfolios formed on I/P and I/C. The returns of the two low I/P portfolios are 0.96% and 0.58%, and the returns on high I/P portfolios are 0.62% and 0.45%. This is consistent with earlier findings that stocks with low investment-to-asset ratios have higher returns, and this holds even when we form portfolios using investment scaled by non-cash assets, rather than total assets. The returns of the two low I/C portfolios are 0.93% and 0.53%, and the returns of the two high I/C portfolios are 0.64% and 0.38%.[21]

To demonstrate that I/C provides additional information beyond that contained in I/P, we construct nine portfolios using I/P and I/C, with all stocks allocated into three I/P groups and into three I/C groups independently, using 30% and 70% breakpoints. At the intersections, we report median values for all nine portfolios. As shown in Table 2, low I/C stocks have higher returns than high I/C stocks for all I/P groups. The excess returns of the three low-I/C portfolios are 0.69%, 0.78% and 0.41%, and the excess returns of the three high-I/C portfolios are 0.44%, 0.39% and 0.39%. Coincidentally, low I/C stocks have low I/P ratios and low I/A (investment-to-asset) ratios and vice versa, suggesting that investment plays a dominant role. However, we find that low I/C stocks have high C/A (cash-to-asset) ratios in all three I/P groups, confirming that low I/C ratios are due to both low investment and high cash, rather than only to low investment.

Table 1

Summary statistics: 07/1964–12/2006. The cash investment factor (INVC) is formed as follows: at the end of June of each year, all stocks (from NYSE, AMEX and NASDAQ) are allocated into two size groups (small and big) based on whether their June market capitalization is above or below the median market value for NYSE stocks. All firms are allocated independently into three investment/cash asset (I/C) groups based on the values of 30% and 70% breakpoints of I/C for NYSE stocks. Six size-I/C portfolios are formed as the intersections of two size groups and three I/C groups. Value weighted monthly returns are calculated for each portfolio from July to the following June. INVC is the difference, each month, between the average returns of two low I/C portfolios and two high I/C portfolios. INVP is constructed using investment/non-cash assets (I/P) following the same approach. We regress INVC on INVP to remove the trend and take the residual as INVC. Investment is defined as the annual change in fixed assets and inventories for firms in COMPUSTAT. Only firms with ordinary common equity classified by CRSP are included in the test and we exclude financial firms. Panel A reports the means and standard deviations of INVP, INVC, the three factors of Fama and French (1996), MKT, SMB and HML, and the Momentum factor from French's website. Panel B reports the correlations. Panel C reports average excess returns of the six size-I/P and the six size-I/C portfolios.

	INVP	INVC	MKT	SMB		HML	MOM
Panel A							
Mean	0.2547	0.0000	0.4592	0.2747		0.4440	0.8157
Std.	1.9134	2.1877	4.4224	3.2728		2.9412	4.0419
Panel B							
INVP			−0.4023	−0.2702		0.6979	−0.0110
INVC			0.1232	0.2881		−0.3812	0.1687
	Small	Big				Small	Big
Panel C							
IP-low	0.9593	0.5778		IC-low		0.9254	0.5249
IP-medium	0.8946	0.3913		IC-medium		0.8107	0.4004
IP-high	0.6240	0.4535		IC-high		0.6425	0.3834

3.3. Two-pass regression using various testing assets

3.3.1. Size-value portfolios

We examine the pricing results of our model, and compare them to the Fama–French three-factor model and the classical CAPM in Table 3. We rely on the Fama and MacBeth (1973) two-pass regression and we follow Cochrane (2001) in adjusting the t-values to account for bias in generated regressors (Shanken, 1992) and autocorrelation and heteroscedasticity (Jagannathan and Wang, 2002). We report both GLS R-squared and adjusted OLS R-squared following Kandel and Stambaugh (1995), Lewellen et al. (2006) and Balvers and Huang (2009), since GLS R-squared measures the maximum mean return that a mean-variance investor can achieve if implied mean returns from a particular model are used as inputs for portfolio optimizations.[22]

Panel A reports testing results using 25 portfolios sorted by size and book-to-market. The CAPM does not perform well in terms of either OLS R-squared or GLS R-squared, yielding 12% in both cases; it also has the wrong sign on market risk premiums. In our model, the risk premiums on market, INVP and INVC are 0.07%, 0.97% and

[18] KZ is the financial constraint index constructed following Lamont et al. (2001) method based on Kaplan and Zingales (1997). Firms with a higher value of KZ index tend to be more financially constrained.

[19] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french.

[20] Financial constraint factor FINC has a negative mean of −1.66%, which is similar to the findings of Lamont et al. (2001), who find that financially constrained firms have low average stock returns. However, Whited and Wu (2006) use another measure for financial constraint, estimating that return differences between more financially constrained firms and less constrained firms are insignificant, albeit positive.

[21] In unreported results, consistent with our theoretical predictions, we find that firms with higher I/C ratios have higher KZ values (are more financial constrained), but, empirically, I/C by itself may be too simple to be the best measure for financial constraint. It is possible that, when expecting a good shock, firms allocate more funds to capital investment and less funds to cash, which choice results in a higher I/C ratio; in the meantime, firms have higher *cashflow* that can support the higher investment and are, thus, less financially constrained.

[22] Grauer and Janmaat (2009) also show that R2 and slopes are unreliable indicators of whether CAPM holds.

Table 2
Portfolios characteristics: I/P and I/C. Stocks are allocated into three I/P groups (investment/non-cash asset) and three I/C groups (investment/cash) independently using 30% and 70% breakpoints of all firms from 7/1964 to 12/2006. Nine I/P–I/C portfolios are formed as the intersections of I/P and I/C portfolios. We report the average excess return (return) and median values for investment/total asset (I/A), investment/non-cash asset (I/P), investment/cash asset (I/C) and cash/total asset (C/A).

I/P	Low			Medium			High		
I/C	Low	Medium	High	Low	Medium	High	Low	Medium	High
Return	0.6939	0.5619	0.4410	0.7841	0.4863	0.3892	0.4057	0.3466	0.3898
I/A	−0.0251	0.0207	0.0265	0.0385	0.0683	0.0922	0.0932	0.1808	0.2679
I/P	−0.0299	0.0215	0.0270	0.0589	0.0782	0.0953	0.2578	0.2494	0.2903
I/C	−0.3265	0.5421	4.9376	0.1462	0.8099	5.1642	0.1774	1.0048	7.3515
C/A	0.0949	0.0579	0.0056	0.3854	0.0978	0.0169	0.6177	0.2057	0.0322

1.12% per month, respectively. The premiums on INVP and INVC factors are both significant, and our model shows a positive sign on market excess return, even though it is still insignificant. The Jensen's α of our three-factor model is only 0.51% with a t-value of 1.29, which is economically and statistically less than 1.31% (t-value of 4.02) of the Fama–French three-factor model, and economically and statistically less than 1.25% (t-value of 3.18) of the CAPM. Although our model's OLS R-squared is 10% lower than that of the Fama–French three-factor model, it is only 1% lower in terms of the GLS R-squared. Excluding the market factor does not lower the overall fit, but the Jensen's α increases to a significant 1.23% when the market factor is excluded.

We break INVA into two components: the value component and the growth component arising from the firm's optimal decision in holding cash. Low I/P stocks have higher future returns because firms invest less when the future discount rate is higher. Low I/C stocks also have higher future returns because high cash holdings lower transaction costs and facilitate building of physical capital. Meanwhile, investing in cash at time t allows firms to play it safe so they can respond to good investment opportunities when they are available, without resorting to sometimes expensive external financing. Thus, cash holdings increase return on physical capital at time $t+1$.

Table 4 provides the betas and the t-values of the market excess return, INVP and INVC for the 25 portfolios, sorted by size and book-to-market ratio. Almost all betas are significant and 11 alphas from the first pass are significant. Value firms have higher betas on INVP, and growth firms have higher betas on INVC. The INVP and INVC betas of small value stocks are 0.40 and 0.13, respectively, but they are −0.84 and 0.79, respectively, for small growth stocks. As a result, growth firms earn higher premiums on the INVC component, and value firms earn higher premiums on the INVP component. Fig. 1 plots the differences of median I/P, I/C and Cinv/A (cash investment divided by lagged total asset) for value stocks and growth stocks for small-, medium- and large-size stocks over time. Value stocks have lower I/P and higher I/C in general, the only exception being the small capitalization category, where the I/C of value stocks is lower.[23] The high I/C of value stocks is partially due to the low cash investments of those firms. Overall, lower I/P and higher I/C give value stocks higher INVP betas and lower INVC betas. Both returns on asset and financial constraint have the wrong sign and do not improve much on the overall fit.

In our model, a firm has a low market-to-book ratio when the weighted average of the two q's is low.[24] On average, value firms have a lower marginal q on physical capital since they usually have abundant physical capital, and the shadow value of that capital is low. On the other hand, value firms have higher marginal q on cash capital because they hold relatively less cash, and the value of additional cash is high.

The marginal q effect on physical capital dominates if the cash capital proportion of total capital is not too large; in our model, value firms have higher returns because of higher return on physical investment. This result is consistent with conventional wisdom, but we provide an additional dimension of variation in the value premium, which is that growth firms earn their return premiums mainly from our INVC factor.

3.3.2. Size-momentum portfolios

Lewellen et al. (2006) point out that portfolios sorted by size and value contain a factor structure, so one should examine whether certain factors still perform well if portfolios with less structure are used as testing assets. We use 25 portfolios sorted by size and momentum as alternative testing assets, given that momentum is difficult to explain. The 25 portfolios are constructed monthly and at the intersections of five portfolios formed on size and five momentum portfolios formed on cumulative return from month $j-12$ to $j-2$ (skipping month $j-1$), where j is the month for portfolio formation. We use the NYSE stock market equity and the prior 2-12 months' cumulative return quintiles as the monthly size and momentum breakpoints, respectively.[25]

Panel B in Table 3 shows that, when the 25 portfolios sorted by size and momentum are used as the testing assets, all models have high α and negative market risk premium, suggesting the challenges the asset pricing models face when confronted with the momentum portfolios. Our model is the only one that has insignificant α(1.85% with t-value of 1.45%). INVP and INVC carry significant risk premiums that are comparable to those achieved when size-value portfolios are used as testing assets. Our model also has the highest GLS R-squared and OLS R-squared, at 67% and 23%, respectively. The latter is, surprisingly, twice that of the Fama–French three-factor model.

When the market factor is excluded, the OLS R-squared and GLS R-squared are 67% and 21%, respectively, but the Jensen's α becomes significant at 1.51%. Adding return on asset increases the OLS R-squared to 83.1% but the coefficient is insignificant and negative.[26] Adding a finance constraint (FINC) also increases the OLS R-squared to 78.3% but it is still insignificant and negative. In all cases, the increases in the GLS R-squared are small. Our ROA factor earns a premium of only five basis points in the time series because we construct ROA using annual data in order to be consistent with the construction of all other factors. It would not surprise us if the performance of ROA improves if we use quarterly data instead to construct ROA, but we leave that for future research.

[23] Value stocks have higher I/C in the two omitted size groups.

[24] In our model, the market-to-book ratio is $\frac{M}{B} = \frac{q_t^p k_{t+1}^p}{k_{t+1}^p + k_{t+1}^c} + \frac{q_t^c k_{t+1}^c}{k_{t+1}^p + k_{t+1}^c}$.

[25] The same timing was used by French to construct the momentum factor. The results are available on his web-site. Chen and Zhang (2009) find that, when testing portfolios are based on a 6-month sorting period and a 6-month holding period, the testing results are similar to those of using a 11-month sorting period and a 1-month holding period.

[26] We also find that, when return on assets (ROA), a proxy for expected future profitability, is included and our INVC factor is dropped, the overall fit is only 15.8%, less than the 19.8% achieved by a single-factor model consisting of only INVC.

Table 3
Two-pass regression. We report risk premiums estimates from the Fama and MacBeth (1973) two-pass estimation, adjusted OLS R-squared (OLSR2) and GLS R-squared (GLSR2) for various testing portfolios. Following Cochrane (2001), we provide *t*-values that adjust for generated regressors, autocorrelation and heteroscadasticity. The MKT, SMB and HML are the Fama–French three factors from French's website. INVP, INVC and ROA are constructed using six portfolios sorted on size and investment/non-cash assets, investment/cash, return on assets, respectively. We remove the INVP component in INVC by regressing INVC on INVP. FINC is the financial constraint factor constructed using six portfolios sorted on size and the Kaplan and Zingales (1997) index. Panel A tests 25 size-value-sorted portfolios; Panel B tests 25 size-momentum sorted portfolios; Panel C tests 25 size-value-sorted portfolios and 30 industry portfolios; and Panel D tests 25 size-value-sorted portfolios, 30 industry portfolios and 25 size-momentum sorted portfolios. The 25 size-momentum portfolios, which are constructed monthly, are the intersections of 5 portfolios formed on size and five momentum portfolios formed on cumulative return from month $j-12$ to $j-2$, where j is the portfolios formation month. Other portfolio data are from French's website. Data are from 7/1964 to 12/2006.

	Panel A: 25 size-value portfolios							Panel B: 25 size-momentum portfolios						
	Constant	MKT				OLSR2	GLSR2	Constant	MKT				OLSR2	GLSR2
Risk premium	0.0125	−0.0049				0.1220	0.1172	0.0110	−0.0041				0.0218	0.0214
t-Value	*3.1838*	*−1.0821*						*3.7260*	*−1.0990*					
	Constant	MKT	SMB	HML		OLSR2	GLSR2	Constant	MKT	SMB	HML		OLSR2	GLSR2
Risk premium	0.0131	−0.0081	0.0022	0.0047		0.7816	0.3201	0.0369	−0.0284	0.0039	−0.0101		0.6380	0.1114
t-Value	*4.0189*	*−2.3822*	*1.4340*	*3.0693*				*3.0806*	*−2.4579*	*2.0797*	*−1.8458*			
	Constant	**INVP**	**INVC**			OLSR2	GLSR2	Constant	**INVP**	**INVC**			OLSR2	GLSR2
Risk premium	0.0123	**0.0092**	**0.0116**			0.6364	0.2997	0.0151	**0.0147**	**0.0220**			0.6675	0.2106
t-Value	*3.8708*	**3.1595**	**2.2715**					*3.9906*	**2.5660**	**2.6848**				
	Constant	MKT	**INVP**	**INVC**		OLSR2	GLSR2	Constant	MKT	**INVP**	**INVC**		OLSR2	GLSR2
Risk premium	0.0051	0.0007	**0.0097**	**0.0112**		0.6764	0.3100	0.0185	−0.0111	**0.0131**	**0.0212**		0.6706	0.2264
t-Value	*1.2892*	*0.1514*	**3.2196**	**2.3949**				*1.4517*	*−0.8888*	**2.0659**	**2.6000**			
	Constant	MKT	INVP	INVC	ROA	OLSR2	GLSR2	Constant	MKT	INVP	INVC	ROA	OLSR2	GLSR2
Risk premium	0.0036	0.0024	0.0117	0.0143	−0.0060	0.6846	0.3414	−0.0062	0.0127	0.0216	0.0303	−0.0080	0.8306	0.2385
t-Value	*0.8965*	*0.5236*	*3.6323*	*3.1800*	*−2.2774*			*−0.7593*	*1.4787*	*2.8017*	*2.6707*	*−1.4332*		
	Constant	MKT	INVP	INVC	FINC	OLSR2	GLSR2	Constant	MKT	INVP	INVC	FINC	OLSR2	GLSR2
Risk premium	0.0052	0.0007	0.0096	0.0111	−0.0018	0.6764	0.3198	−0.0012	0.0090	0.0263	0.0398	−0.0178	0.7825	0.2304
t-Value	*1.4161*	*0.1621*	*3.3080*	*2.8223*	*-0.7107*			*−0.0947*	*0.7828*	*2.5098*	*2.1518*	*−1.3860*		
	Panel C: 25 size-value + 30 industry portfolios							Panel D: 25 size-value + 30 industry + 25 size-momentum portfolios						
	Constant	MKT				OLSR2	GLSR2	Constant	MKT				OLSR2	GLSR2
Risk premium	0.0076	−0.0011				0.0086	0.0139	0.0083	−0.0017				0.0110	0.0052
t-Value	*2.6085*	*−0.2857*						*2.9566*	*−0.4718*					
	Constant	MKT	SMB	HML		OLSR2	GLSR2	Constant	MKT	SMB	HML		OLSR2	GLSR2
Risk premium	0.0081	−0.0028	0.0020	0.0028		0.3487	0.1185	0.0141	−0.0085	0.0023	0.0018		0.2373	0.0617
t-Value	*3.4618*	*−0.9327*	*1.2639*	*1.7865*				*5.6149*	*−2.7570*	*1.4459*	*1.1256*			
	Constant	**INVP**	**INVC**			OLSR2	GLSR2	Constant	**INVP**	**INVC**			OLSR2	GLSR2
Risk premium	0.0086	**0.0031**	**0.0033**			0.1245	0.1094	0.0104	**0.0062**	**0.0083**			0.2425	0.1183
t-Value	*4.3051*	**1.8346**	**1.7204**					*4.9021*	**3.5913**	**3.7633**				
	Constant	MKT	**INVP**	**INVC**		OLSR2	GLSR2	Constant	MKT	**INVP**	**INVC**		OLSR2	GLSR2
Risk premium	0.0047	0.0013	**0.0040**	**0.0037**		0.1746	0.1096	0.0083	−0.0019	**0.0068**	**0.0086**		0.2493	0.1203
t-Value	*1.6578*	*0.3370*	**2.1393**	**1.7374**				*2.5046*	*−0.4362*	**3.5527**	**3.5425**			
	Constant	MKT	INVP	INVC	ROA	OLSR2	GLSR2	Constant	MKT	INVP	INVC	ROA	OLSR2	GLSR2
Risk premium	0.0052	0.0007	0.0034	0.0028	−0.0027	0.1919	0.1130	0.0071	−0.0006	0.0075	0.0097	−0.0037	0.2648	0.1229
t-Value	*1.9771*	*0.1950*	*1.6802*	*1.1365*	*−1.7793*			*2.3294*	*−0.1509*	*3.6554*	*3.6292*	*−2.0363*		
	Constant	MKT	INVP	INVC	FINC	OLSR2	GLSR2	Constant	MKT	INVP	INVC	FINC	OLSR2	GLSR2
Risk premium	0.0059	−0.0001	0.0038	0.0031	0.0011	0.2388	0.1216	0.0097	−0.0035	0.0063	0.0075	−0.0004	0.2827	0.1219
t-Value	*2.1409*	*−0.0156*	*2.0530*	*1.5046*	*0.7105*			*3.1236*	*−0.8715*	*3.3797*	*3.2405*	*−0.2560*		

Table 4
Betas: size-value portfolios. Betas and *t*-values are from Fama–MacBeth two-pass regression. MKT is the market excess return from French's website. INVP and INVC are constructed using six portfolios sorted on size and investment/non-cash assets and investment/cash, respectively. We remove the INVP component in INVC by regressing INVC on INVP. Data are from 7/1964 to 12/2006.

		Betas					*t*-Values				
		Small		Medium		Big	Small		Medium		Big
Alpha	Growth	−0.0013	0.0002	0.0008	0.0018	0.0004	−0.6101	0.1158	0.6053	2.0189	0.4909
		0.0044	0.0018	0.0018	−0.0009	−0.0009	2.3306	1.3265	1.6959	−1.0974	−1.4109
	Blend	0.0039	0.0037	0.0012	0.0010	−0.0006	2.3968	2.9562	1.2457	1.3054	−0.8041
		0.0058	0.0040	0.0023	0.0019	−0.0003	3.7232	3.2531	2.3533	2.1394	−0.3622
	Value	0.0059	0.0037	0.0033	0.0012	−0.0003	3.4976	2.5652	2.6555	1.1443	−0.2298
MKT	Growth	1.2806	1.2985	1.2183	1.1331	0.9448	25.3495	34.3402	40.2814	52.4251	52.8084
		1.1384	1.1652	1.1558	1.1556	1.0359	24.8106	34.6904	45.2678	58.9433	64.4726
	Blend	1.0755	1.0944	1.0797	1.1015	0.9517	27.1586	35.9202	46.2585	56.2873	48.4744
		1.0337	1.0646	1.0374	1.0424	0.9388	27.1822	35.5908	43.6736	48.4985	47.8539
	Value	1.0992	1.1580	1.1452	1.1734	0.9802	26.6950	32.9086	37.7041	44.3976	32.6952
INVP	Growth	−0.8385	−0.7551	−0.7415	−0.6285	−0.3264	−7.2365	−8.7060	−10.6893	−12.6787	−7.9526
		−0.4434	−0.0770	0.1541	0.3420	0.3780	−4.2130	−0.9998	2.6319	7.6052	10.2564
	Blend	−0.0134	0.2519	0.4703	0.5515	0.4725	−0.1471	3.6048	8.7849	12.2877	10.4928
		0.1967	0.4034	0.5921	0.6175	0.6753	2.2550	5.8795	10.8677	12.5264	15.0085
	Value	0.4038	0.5388	0.7353	0.8704	0.7267	4.2757	6.6758	10.5546	14.3592	10.5691
INVC	Growth	0.7891	0.4758	0.4308	0.3513	0.0751	8.4398	6.7989	7.6968	8.7833	2.2668
		0.5885	0.0921	−0.1123	−0.2556	−0.2727	6.9301	1.4821	−2.3754	−7.0442	−9.1693
	Blend	0.2636	−0.1208	−0.3021	−0.3848	−0.3000	3.5959	−2.1421	−6.9942	−10.6261	−8.2556
		0.1584	−0.1226	−0.3339	−0.3015	−0.5153	2.2509	−2.2143	−7.5955	−7.5786	−14.1921
	Value	0.1274	−0.0948	−0.2761	−0.4435	−0.4359	1.6712	−1.4551	−4.9123	−9.0670	−7.8556

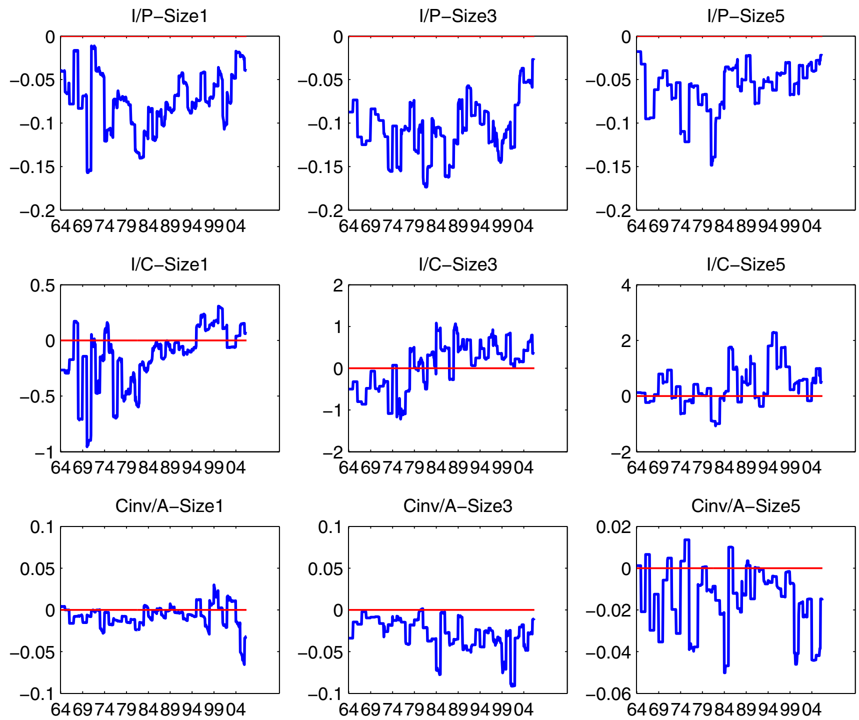

Fig. 1. We plot the differences of median I/P, I/C, Cinv/A (cash investment divided by lagged total asset) for value stocks and growth stocks for small, medium and large sizes (size 1, 3 and 5) for period 07/1964–12/2006.

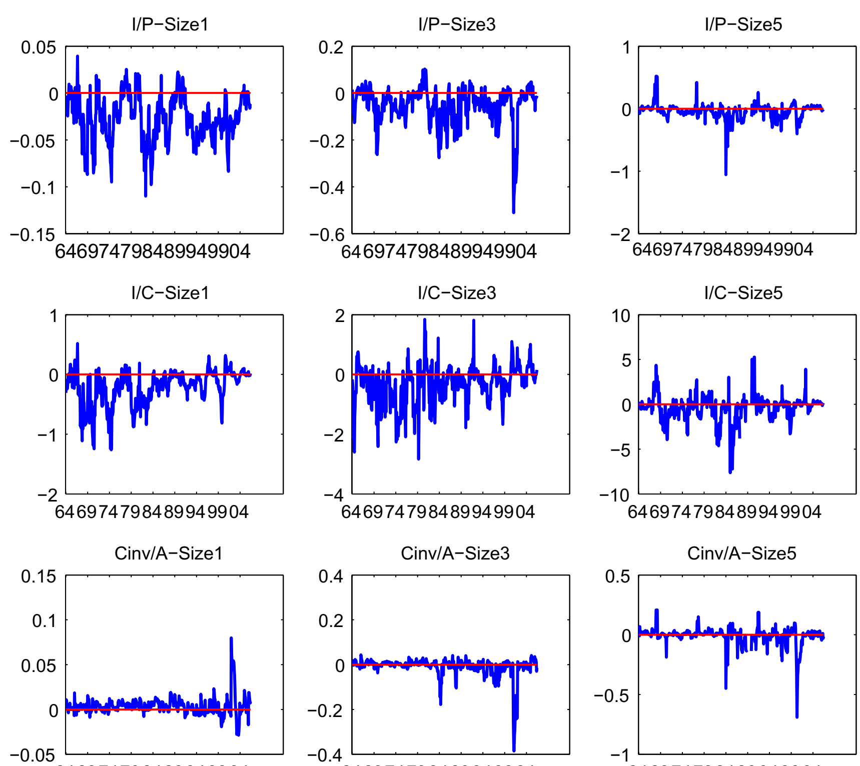

Fig. 2. We plot the differences of median I/P, I/C, Cinv/A (cash investment divided by lagged total asset) for winner stocks and loser stocks for small, medium and large sizes (size 1, 3 and 5) for period 07/1964–12/2006.

Fig. 2 plots the differences of median I/P, I/C and Cinv/A (cash investment divided by lagged total asset) for value stocks and growth stocks for three size groups over time. We find that winner stocks have lower I/P ratios, consistent with the findings of Chen and Zhang (2009) in that winners invest less before the formation of portfolios. We also find that winner stocks have lower I/C ratios and it arises when cash investment is relatively higher.

Table 5
Regression at firm level

Model		Constant	logME	logBEME	Mom	I/A	I/P	I/C	C/A	OLSR2
1	Average	1.9308	−0.1846	0.3784	0.4969	−0.6347				0.0182
	t-Statistic	22.15	−10.93	15.40	8.49	−19.17				
2	Average	1.8430	−0.1806	0.4058	0.4940		−0.2709	−0.0047	0.7629	0.0189
	t-Statistic	44.64	−21.64	34.64	17.00		−24.45	−14.99	14.30	

3.3.3. Industry portfolios

As a further robustness check, Panel C in Table 3 reports results using 55 testing assets, consisting of 25 assets sorted by size and value and 30 industry portfolios (Lewellen et al., 2006), and Panel D in Table 3 reports results using all testing assets.

Panel C shows that none of the models perform as well as they do for the 25 assets sorted by size and value. The fits of the models are substantially lower, ranging from 1% to 34.9% in terms of OLS R-squared and 1.4% to 11.9% in terms of GLS R-squared. Both the CAPM and the Fama–French three-factor model have the wrong sign on the market, and our model is the only one that has an insignificant alpha (0.47% with *t*-value of 1.66). Our model has a GLS R-squared of 10%, which is slightly lower than that of the Fama–French three-factor model. Return on assets and financial constraint are insignificant. Panel D shows similar findings. The notable results are now that INVP and INVC become significant at 5% level, and Fama–French three-factor model has a GLS R-squared of only 6.2%. Overall our INVP and INVC remain significant (falthougth they are weaker in Panel C). Including return on assets and financial constraint increases the OLS R-squared but barely increases the GLS R-squared.

3.4. Cross-sectional regressions at firm level

A standard question is whether the anomalies can predict future equity returns on the margin. To address this issue, we follow the Fama–MacBeth approach adopted in Fama and French (2008). A cross-section regression is estimated in each month to predict monthly returns from July of year t to June of year $t+1$. Independent variables include common anomaly variables such as market cap (logME), book-to-market equity (logBEME) and momentum (Mom), as well as our INVP and INVC measures. Explanatory variables are assumed to be observable in June of year t or earlier and are measured only once a year with the exception of momentum, which is calculated monthly. We decided not to include estimated market betas in the cross-section regressions following Fama and French (2008).[27]

We report our findings in Table 5. They are similar to those of Fama and French (2008) in that average regression slopes are highly significant-negative for market capitalization and positive for book-to-market equity and momentum. The coefficient of I/A is negative and significant (-0.63 with a t-value of -19.17), which confirms the predictions of the investment-based models that firms with high investments tend to have low expected stock returns. By breaking I/A into two components, I/P and I/C, we find the coefficients on both (-0.27 and -0.0047, respectively) are negative and significant (t-values are -24.45 and -14.99, respectively). However, C/A remains positive and significant (0.76 with t-value of 14.30) in predicting future returns. Our findings confirm our theoretical prediction that firms with higher I/P and I/C ratios tend to yield lower stock returns, meaning that firms that make smaller investments in physical assets and hold larger amounts of cash generate higher future returns.

4. Concluding remarks

Traditional investment- or production-based asset pricing models suggest that investments should negatively covary with future equity returns over time because firms will invest more when they expect future discount rates to fall. Recent work has used investments and profitability as pricing factors and find that they help to explain the cross-sectional variations of stock returns. We examine the impact of firms' investments relative to cash holdings on expected equity returns in an investment-based asset pricing model with debt financing. It is important that firms consider the role of cash when making investment decisions because having cash provides convenience, is consistent with the precautionary motive, and lowers future external financing costs.

We find that cash increases the expected return on physical capital and on the expected future stock returns. We also demonstrate that a three-factor model, consisting of the market return, a factor based on investment relative to non-cash capital (INVP), and a factor based on investment relative to cash capital (INVC), explains a significant portion of variations of cross-sectional stock returns compared to other popular asset pricing models. Our results show that value (growth) firms are more sensitive to the INVP (INVC) factor and that momentum (loser) stocks earn higher premiums on the INVC (INVP) factor. When alternative proxies for future productivity and financial constraints are included in the testing, INVP and INVC remain significant.

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Appendix A

We show how stock price is derived and suppress some time subscripts for notational simplicity. Note that to solve analytically we require the CES property on the functions for the profit, adjustment cost related to non-cash capital, adjustment cost related to cash capital and external financing cost. The CES assumption clearly is not general enough but the assumption can be relaxed if the purpose is not to solve the model analytically. Using Eq. (1) and expanding Eq. (4), the value function, we get

$$\begin{aligned} V_t = {} & (1+\mathbb{1}_b\lambda_1)(\Theta_t k_t^p - i_t^p - \phi_1 i_t^p - \phi_2 k_t^p - i_t^c - T_1 i_t^p - T_2(k_t^c + i_t^c)) \\ & - q_t^p[\underbrace{k_{t+1}^p} - (1-\delta_p)k_t^p - i_t^p] - q_t^c[\underbrace{k_{t+1}^c} - (1-\delta_c)k_t^c - i_t^c] \\ & + E_t M_{t+1}\{(1+\mathbb{1}_b\lambda_1)(\pi_1 k_{t+1}^p - i_{t+1}^p - \phi_1 i_{t+1}^p - \phi_2 k_{t+1}^p - i_{t+1}^c \\ & - T_1 i_{t+1}^p - T_2(k_{t+1}^c + i_{t+1}^c)) - q_{t+1}^p[\underbrace{k_{t+2}^p} - (1-\delta_p)k_{t+1}^p - i_{t+1}^p] \\ & - q_{t+1}^c[\underbrace{k_{t+2}^c} - (1-\delta_c)k_{t+1}^c - i_{t+1}^c]\} + \dots \end{aligned} \tag{18}$$

[27] Fama and French (2008) argue that the betas of the three-factor model tend to be much less dispersed than the CAPM betas: The premium for the three-factor beta is smaller than the average market excess return, individual firm betas are unlikely to be correlated with the anomaly variables, and estimates for individual firm betas are imprecise. The authors conclude that omitting market beta in the cross-section regression should have little impact.

where terms with curly brackets are to be canceled recursively. Applying Eqs. (5) and (6), the first-order conditions and canceling terms recursively, we have:

$$\begin{aligned} V_t &= (1+\mathbb{1}_b\lambda_1)\Theta_t k_t^p + [q_t^p(1-\delta_p) - \phi_2(1+\mathbb{1}_b\lambda_1)]k_t^p \\ &\quad + [q_t^c(1-\delta_c) - T_2(1+\mathbb{1}_b\lambda_1)]k_t^c - Lim_{s\to\infty}M_{t+s}q_{t+s}^p k_{t+1+s}^p \\ &\quad - Lim_{s\to\infty}M_{t+s}q_{t+s}^c k_{t+1+s}^c \end{aligned} \tag{19}$$

and the last two terms equal zero following the usual transversality conditions. Let the ex-dividend stock price today be:

$$\begin{aligned} p_t &= V_t - [\pi_t - i_t^p - \Phi_t - T_t - i_t^c - \mathbb{1}_b\lambda(b_t)] \\ &= V_t - [\pi_t - i_t^p - \Phi_t - T_t - i_t^c](1+\mathbb{1}_b\lambda_1) \end{aligned} \tag{20}$$

If we plug V_t back into the definition of stock price and cancel terms we have:

$$\begin{aligned} p_t &= [q_t^p(1-\delta_p)]k_t^p + [q_t^c(1-\delta_c)]k_t^c + (1+\mathbb{1}_b\lambda_1)[i_t^p + \phi_1 i_t^p + T_1 i_t^p + i_t^c] \\ &= q_t^p k_{t+1}^p + q_t^c k_{t+1}^c \end{aligned} \tag{21}$$

Combining the definition for dividend and ex-dividend stock price, we can show that stock return is an average of return on physical capital investment and return on cash holdings

$$\begin{aligned} r_{t+1} &= \frac{p_{t+1}+d_{t+1}}{p_t} \\ &= \frac{q_{t+1}^p k_{t+2}^p + q_{t+1}^c k_{t+2}^c + (1+\mathbb{1}_b\lambda_1)[\pi_{t+1} - i_{t+1}^p - \phi_{t+1} - T_{t+1} - i_{t+1}^c]}{p_t} \\ &= \frac{[(1+\mathbb{1}_b\lambda_1)(\Theta_{t+1}-\phi_2) + q_{t+1}^p(1-\delta_p)]k_{t+1}^p}{p_t} \\ &\quad + \frac{[(1+\mathbb{1}_b\lambda_1)(-T_2) + q_{t+1}^c(1-\delta_c)]k_{t+1}^c}{p_t} \\ &= r_{t+1}^p \frac{q_t^p k_{t+1}^p}{p_t} + r_{t+1}^c \frac{q_t^c k_{t+1}^c}{p_t} \end{aligned} \tag{22}$$

where the derivation of the third equality needs to use the definition of k_{t+2}^p and k_{t+2}^c, as well as the CES properties.

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