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ABSTRACT

Asset Pricing Implications of Firms' Financing Constraints*

We incorporate costly external finance in a production based asset pricing model and investigate whether financing frictions are quantitatively important for pricing a cross-section of expected returns. We show that the common assumptions about the nature of the financing frictions are captured by a simple 'financing cost' function, equal to the product of the financing premium and the amount of external finance. This approach provides a tractable framework to examine the role of financing frictions in pricing across-section of asset returns. Using the Generalized Method of Moments (GMM) we estimate a pricing kernel that incorporates the effects of financing constraints on investment behaviour. The key ingredients in this pricing kernel depend not only on 'fundamentals', such as profits and investment, but also on the financing variables. Our findings, however, suggest that the role played by financing frictions is fairly negligible, unless the premium on external funds is procyclical, a property not evident in the data and not satisfied by most models of costly external finance.

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1 Introduction

In this paper we ask whether financing constraints are quantitatively important in explaining a cross-section of expected returns. Specifically, we incorporate costly external finance into a production based asset pricing model and investigate whether financing frictions help in pricing the cross-section of expected returns.

Our analysis, as in Cochrane (1991, 1996), focuses on the link between asset returns and the returns on physical investment implied by the optimal production and investment decisions of the firm. Our contribution is in augmenting this basic framework to explicitly consider the impact of financing frictions on the optimal decisions of the firm. To avoid specifying the underlying source of these frictions (e.g., asymmetric information, costly state verification or "lemon problems") we show that the typical assumptions about the nature of the financing frictions, as modelled in the existing literature, are captured by a simple "financing cost" function, equal to the product of the financing premium and the amount of external finance. Since both of these quantities are relatively easy to observe, this approach provides a tractable (and fairly general) framework to examine the role of financing frictions in pricing a cross-section of asset returns.

Our empirical analysis uses the Generalized Method of Moments (GMM) to explore the Euler equation restrictions imposed on expected returns by optimal investment behavior. Since this behavior is affected by the presence of the financing frictions, the returns to physical investment will depend on the financing variables. Thus, the ability of investment returns to price the cross section of expected returns will depend not only on "fundamentals" such as profits and investment, as in Cochrane (1996), but also on the financing variables.

As with any asset pricing model, financial frictions will be relevant for the pricing of expected returns only to the extent that they provide a *common* factor — in this context one associated with financial distress as systematic (aggregate) risk, e.g. Chan and Chen (1991) and Fama and French (1993, 1996). Thus, our focus on the importance of financing frictions through their effects on pricing *expected* returns seems a natural benchmark from the standpoint of asset pricing.

Our empirical findings suggest that the role played by financing frictions is fairly negligible, unless the premium on external funds is procyclical, a property not evident in the data and not satisfied by most models of costly external finance. Our results are also robust to several alternative formulations of our model, particularly the form of the financing cost function, the specific data used, and the set of returns used in our GMM implementations.

The intuition for this result is simple. Absent financing frictions, firms would increase investment immediately in response to positive news about expected future productivity growth. This, in turn, generates a series of investment returns that lead the cycle, and results in a large correlation between current investment returns and future profits — a feature also documented by Fama and Gibbons (1982) for observed stock returns. In the presence of financing constraints, however, the countercyclical nature of the financing premium implies that the expected rise in future productivity is also associated with lower future expected financing costs. This induces firms to try to capitalize on the lower expected costs by delaying their investment response, which changes the implied dynamics of investment returns and lowers their correlation with the observed stock returns.

Our findings contribute to two strands of the literature in economics and finance. First, from an asset pricing perspective, they suggest that financing variables are not an important factor in pricing the cross-section of asset returns. Although our approach to incorporate financing frictions as a pricing factor is more structural, our results seem to complement those in Lamont, Polk, and Saá-Requejo (2000). Using an aggregate index of financing frictions as a common factor in an asset pricing model, they also document that the cyclical fluctuations in asset returns do not appear to be linked to financial frictions. Together, these results seem to support recent work that emphasizes the role of firm productivity and growth in generating the observed cross-sectional variations in returns in a risk based paradigm (e.g., Berk, Green, and Naik (1999), Gomes, Kogan, and Zhang (2002), and Zhang (2002)).

In addition, in the macroeconomic literature, several authors have argued that financing constraints improve the ability of macroeconomic models to replicate the behavior of typical macro aggregates.[1] Our findings suggest, however, that those models' ability to match financial data is severely strained unless the implied costs of external finance are procyclical, thus placing important restrictions on the nature of the financing frictions supported by the data.

In addition to Cochrane (1991, 1996) we also build on additional theoretical work by Restoy and Rockinger (1994) who generalize some of the results in Cochrane (1991) to an environment with investment constraints, and on Bond and Meghir (1994) who explicitly characterize the effects of financing frictions on the optimal investment decisions of the firm.

Finally, our work is also related to research by Li, Vassalou and Xing (2001) who compare the performance of alternative investment growth factors in pricing the Fama and French (1993) size and book to market portfolios, and to work by Lettau and Ludvigson (2001) who re-examine the empirical link between aggregate investment and stock returns using information about the consumption to wealth ratio.

The remainder of this paper is organized as follows. Section 2 shows that much of the existing literature on firms' financing constraints can be characterized by specifying a simple dynamic problem to describe firm behavior. Section 2 also derives the expression for returns

[1] See, among others, Bernanke and Gertler (1989), Bernanke, Gertler, and Gilchrist (2000), den Haan, Ramey, and Watson (1999), and Kiyotaki and Moore (1997).

to physical investment, and its relation to stock and bond returns, which can be used to evaluate the asset pricing implications of the model. The next section describes our data sources and econometric methods, while Section 4 reports the results of our GMM tests and examines both the performance of the model and the role of financing constraints. The robustness of our results to the use of alternative data or modelling assumptions is examined in Section 5. Finally, Section 6 offers some concluding remarks.

2 Investment Based Asset Pricing with Costly External Finance

In this section we incorporate costly external finance in Cochrane's (1996) production based asset pricing framework. We do this by summarizing the common properties of alternative models of financing frictions with a very simple set of restrictions on the costs of external funds. We then show that this formulation leads to a fairly simple characterization of the optimal investment decisions of the firm and derive a set of easily testable asset pricing conditions that shed light on the role of financing frictions.

2.1 Modelling Financing Frictions

Theoretical foundations of financing frictions have been provided by several researchers over the years and we do not attempt to provide yet another rationalization for their existence. Rather, we seek to summarize the common ground across much of the existing literature with a representation of financing constraints that is both parsimonious and empirically useful.

While exact assumptions and modelling strategies can differ quite significantly across the various models, most share the key feature that external finance (equity or debt) is more "costly" than internal funds. It is this crucial property that we explore in our analysis below by assuming that the financial market imperfections will be entirely captured by the unit costs of raising external finance.

Consider first the case of equity finance. Suppose a firm issues an amount N in new shares and let W denote the reduction on the claim of existing shareholders associated with the issue of one dollar of new equity. Clearly, in a Modigliani-Miller world $W = 1$ since the total value of the firm is unaffected by financing decisions. If Modigliani-Miller fails to hold however, new equity lowers the total value of the firm, and $W > 1$. Now, new issues are costly to existing shareholders, not only because they reduce claims on future dividends, but because they also reduce value due to the presence of additional transaction or informational costs.[2]

Suppose now that the firm decides to use debt financing, B, and let the function R denote the future repayment costs of this debt.[3] If Modigliani-Miller holds these repayments will just equal the opportunity cost of internal funds, captured by the relevant discount factor for shareholders, M. In this case we will simply have that $\mathrm{E}[MR(\cdot)] = 1$, where $\mathrm{E}[\cdot]$ denotes the expectation over the relevant probability measure. Absent Modigliani-Miller, debt is more costly than internal funds and $\mathrm{E}[MR(\cdot)] > 1$, at least when $B > 0$.[4]

In addition, it is often assumed that the "financing costs" are increasing in the amount of external finance, so that $\partial W(\cdot)/\partial N$ and $\partial R(\cdot)/\partial B$ are positive. It also seems reasonable to assume that the costs depend on the amount of financing normalized by firm size, K, which allows for the possibility that large firms will face lower financing costs. Finally, these costs may also be state-dependent. In this case we would write $W(\cdot) = W\left(N/K, X\right)$, where X summarizes both firm-level and aggregate uncertainty, and similarly $R(\cdot) = R\left(B/K, X\right)$.

[2] E.g., Jensen and Meckling (1976), Myers and Majluf (1984), and Greenwald, Stiglitz, and Weiss (1984)

[3] If there is no possibility of default these costs will just equal the gross interest on the loan. If default is allowed, they may depend on the liquidation value of the firm.

[4] E.g., Myers (1977), Townsend (1979), Stiglitz and Weiss (1981), Diamond (1984), Gale and Hellwig (1985), and Bernanke and Gertler (1990)

These additional properties are also common and fairly intuitive. We summarize them in Assumption 1.

Assumption 1 *Let X summarize all forms of uncertainty. The cost functions $W(\cdot)$ and $R(\cdot)$ satisfy:*

$$W(N/K, X) > 1, \quad W_1(\cdot) \equiv \partial W(\cdot)/\partial N \geq 0 \quad \text{for} \quad N > 0 \tag{1}$$

and

$$\mathrm{E}_t[MR(B/K, X)] \geq 1, \quad R_1(\cdot) \equiv \partial R(\cdot)/\partial B \geq 0 \quad \text{for} \quad B > 0 \tag{2}$$

This is a very weak assumption as it merely requires that external finance, whether debt or equity, is more expensive than internal funds, with non-decreasing unit costs.

Essentially, the existing corporate finance literature has focused so far on establishing the nature and properties of the functions $W(\cdot)$ and $R(\cdot)$, by concentrating on optimal contracts in the presence of transaction costs, moral hazard, asymmetric information or costly-state verification. These alternative arguments provide different rationales, and sometimes different forms, for the functions $W(\cdot)$ and $R(\cdot)$, but most share the basic properties captured by our assumption. By focusing on the common ground across much of this existing literature on financing frictions, we seek to provide a fairly general test of the role that these constraints play in determining asset prices.[5]

[5]A recent strand of literature on financing frictions focus instead on "quantity" constraints of varying complexity (e.g. Kehoe and Levine (1993), Hart and Moore (1996), Kotcherlakotta (1996), Zhang (1997), Alvarez and Jermann (2000), Albuquerque and Hopenhayn (2001), Clementi and Hopenhayn (2001) and Cooley, Quadrini, and Marimon (2001)). In general these models do not satisfy our assumptions. Strictly speaking then, our characterization below applies only to models of "costly" external finance.

2.2 Firm's Problem

Consider the problem of a firm seeking to maximize the value to existing shareholders, denoted $V(\cdot)$, in an environment where external finance is costly. This firm makes investment decisions by choosing now the optimal amount of capital to have at the beginning of the next period, K_{t+1}. Investment spending, I_t, as well as dividends, D_t, can be financed with internal cash flows $\Pi(\cdot)$, new equity issues, N_t, or one period debt B_{t+1}.[6]

The problem of this firm can then be summarized by the following dynamic program:

$$
\begin{aligned}
V(K_t, B_t, X_t) \quad &= \quad \max_{\substack{D_t, B_{t+1},\\ K_{t+1}, N_t}} \left\{ D_t - W\left(N_t/K_t, X_t\right) N_t + \mathrm{E}_t\left[M_{t,t+1} V(K_{t+1}, B_{t+1}, X_{t+1})\right] \right\} && (3)\\
\text{s.t.} \quad & \quad D_t = C_t + N_t + B_{t+1} - R(B_t/K_t, X_t) B_t && (4)\\
& \quad I_t = K_{t+1} - (1-\delta) K_t, \qquad \delta \geq 0 && (5)\\
& \quad C_t = \Pi(K_t, X_t) - I_t - \frac{a}{2}\left[I_t/K_t - \delta\right]^2 K_t \qquad a \geq 0 && (6)\\
& \quad D_t \geq \overline{D}, \quad N_t \geq 0
\end{aligned}
$$

where $M_{t,t+1}$ is the stochastic discount factor (of the owners of the firm) from time t to $t+1$ and $\overline{D}$ is the firm's minimum, possibly zero, dividend payment. Note that firms can accumulate financial assets, in which case debt is negative. The cash flow function, $\Pi(\cdot)$, is assumed to exhibit constant returns scale, but its exact form is unimportant.

Equation (4) shows the resource constraint of the firm. It implies that dividends must equal internal funds, net of investment spending, C_t, plus new external funds, net of debt repayments. Equation (5) is the standard capital accumulation equation, relating current investment spending, I_t, to future capital, K_{t+1}. We assume that old capital depreciates at the rate δ. As in Cochrane (1991, 1996), investment requires the payment of adjustment

[6] One-period debt simplifies the algebra considerably but has no bearing on our results.

costs, captured by the term $\frac{a}{2}\left[I_t/K_t-\delta\right]^2 K_t$.

Given our assumptions, it is immediate that the firm will only use external finance after internal cash flows are exhausted and no dividends are paid, above the required level $\overline{D}$. Conversely, dividends will exceed this minimum only if no external funds are required to finance them. Hence, the model extends the familiar hierarchical financing derived by Myers (1984) in a static framework to a dynamic setting.

2.3 Asset Pricing Implications

To save notation it is convenient to combine the constraints (4)-(6) by eliminating investment, and noting that $C_t = C(K_t, K_{t+1}, X_t)$. The asset pricing implications of the model can then be summarized by arranging the optimality conditions with respect to K_{t+1} and B_{t+1} to obtain:

$$\begin{aligned}
\mathrm{E}_t[M_{t,t+1}R^I_{t+1}] &= \mathrm{E}_t\left[M_{t,t+1}\left(\frac{V_1(K_{t+1},B_{t+1},X_{t+1})}{-\mu_t C_2(K_t,K_{t+1},X_t)}\right)\right]=1 &(7)\\
\mathrm{E}_t[M_{t,t+1}R^B_{t+1}] &= \mathrm{E}_t\left[M_{t,t+1}\left(\frac{V_2(K_{t+1},B_{t+1},X_{t+1})}{-\mu_t}\right)\right]=1 &(8)
\end{aligned}$$

where R^I_{t+1} and R^B_{t+1} denote the returns on physical investment and debt, respectively, and μ_t is the Lagrange multiplier on the combined constraint.

Equations (7) and (8) provide a simple summary of the role of financing constraints for the optimal behavior of firms. For empirical purposes, however, this characterization is extremely difficult to implement, since it requires an explicit solution to the value function, $V(K_t, B_t, X_t)$, as well as the multiplier, μ_t. More importantly, this procedure requires more stringent assumptions about the nature of the cost functions, $W(\cdot)$ and $R(\cdot)$ than those provided in Assumption 1, thus rendering our tests below dependent on these specific functional form restrictions.

Instead, we pursue an alternative approach by exploiting the fact that the solution to the problem above can be characterized by solving the following "frictionless" problem

$$\widetilde{V}(K_t, B_t, X_t) = \max_{K_{t+1}} \left\{ \widetilde{C}(K_t, K_{t+1}, X_t) + \mathrm{E}_t \left[M_{t,t+1} \widetilde{V}(K_{t+1}, B_{t+1}, X_{t+1}) \right] \right\}, \tag{9}$$

where

$$\widetilde{C}(K_t, K_{t+1}, X_t) = C(K_t, K_{t+1}, X_t) - b(X_t) \times E_t \tag{10}$$

and $\widetilde{V}(\cdot)$ denotes the total value of the firm for both stock and bond holders.

The linear term $b(X_t) \times E_t$ captures the role of the financing frictions. Here, $b(X_t) \geq 0$ is the (possibly stochastic) premium on external finance, and $E_t = B_{t+1} + N_t$ denotes the total amount of external finance used by the firm. Using the resource constraint, E_t can be computed as:

$$E_t = B_{t+1} + N_t = R_t B_t + \overline{D} - C(K_t, K_{t+1}, X_t) \tag{11}$$

Proposition 1 formally establishes the equivalence between the formulation in (9) and the original problem in (3).[7]

Proposition 1 *Let the adjusted cash flow function $\widetilde{C}(\cdot)$ be given by (10). Then the two dynamic programs (3) and (9) produce the same solution.*

Proof We present the proof for the case of equity finance only. The proof for the case with debt is provided in the appendix. When firms issue only new equity, $B_t = B_{t+1} = 0$, and $E_t = N_t$. Replacing the resource constraints in (3) we obtain

$$V(K_t, X_t) = \max_{K_{t+1}, N_t} \{ C(K_t, K_{t+1}, X_t) - (W(\cdot) - 1) N_t + \mathrm{E}_t \left[M_{t,t+1} V(K_{t+1}, X_{t+1}) \right] \}$$

[7] Gilchrist and Himmelberg (1998) use a similar cost representation for the case of debt finance. Effectively Proposition 1 rationalizes their result for a much larger class of models.

Letting $b(X_t) = (W(\cdot) - 1)$ be the premium on external finance, it follows that

$$\widetilde{C}(K_t, K_{t+1}, X_t) = C(K_t, K_{t+1}, X_t) - (W(\cdot) - 1)N_t.$$

■

While the proof for the case of debt financing requires a fairly elaborate verification of integrability conditions, the basic argument of the proof lies in the characterization of the multiplier. In some sense this proposition merely explores the fact that one can always rewrite a constrained problem as an unconstrained one with embedded multipliers. What is novel here is the precise characterization of the multiplier, μ_t, as a measure of the premium on external finance. By linking this "shadow-price" to an essentially observable variable, we are able to recast the problem in a way that lends itself to empirical analysis.

Our financing cost function provides a very simple, but quite general, characterization of the financing constraints. It implies that they can be effectively summarized by the product of two terms, one, E_t, which captures the amount of external finance raised, and the other, $b(\cdot)$, summarizing the premium on external funds.

In addition, the optimality conditions from the "frictionless" problem (9) imply that the return on investment equals:

$$R^I_{t+1}(i, \pi, b) = \frac{(1 + b(X_{t+1}))(\pi_{t+1} i_{t+1} + \frac{a}{2} i^2_{t+1} + (1 + a i_{t+1})(1 - \delta))}{(1 + b(X_t))(1 + a i_t)} \tag{12}$$

where $i \equiv (I/K)$ is the investment to capital ratio, and $\pi \equiv (\Pi/I)$ is the profit to investment ratio. Note that E_t does not enter 12 since the amount of external finance depends on these two variables. To complete our description of investment returns all we need is a specification for the premium on external finance. While several measures can be used it seems natural to start by assuming that it is proportional in the default premium, DF_t:

$$b(X_t) = b \times DF_t \qquad b \geq 0.$$

and b is a parameter to be estimated in our empirical work. Thus, investment returns are entirely driven by the two "fundamentals", i and π, as well as the cyclical properties of the financing premium. This implementation is very appealing from an empirical point of view, since it requires only a measure of the premium on external finance as well as data on profits, investment and financing variables.

Finally, our approach also provides a measure of the economic magnitude of the financing costs. Specifically, the ratio of these costs to investment spending provides a meaningful measure of the importance of the financing costs. Hence, our alternative characterization provides not only a useful tool for empirical analysis but also a simple and straightforward measure of the magnitude of the financing costs.

3 Investment Based Factor Pricing Models

This section describes our empirical methodology in detail and it provides an overview of our data sources and the construction of the series of returns.

3.1 Asset Pricing Tests

The essence of our strategy is to use the information contained in the asset prices restrictions above to formally investigate the importance of financing constraints. As we have seen in the previous section, these restrictions are summarized by the Euler equations:

$$\mathrm{E}_t(M_{t,t+1} R^I_{n,t+1}) = \mathrm{E}_t(M_{t,t+1} R^B_{l,t+1}) = 1 \tag{13}$$

for investment returns, $R^I_{n,t+1}$, $n = 1, 2, ...J_I$, and bond returns $R^B_{l,t+1}$, $l = 1, 2, ...J_B$. In addition, Proposition 2 shows a similar restriction must also hold for stock returns $R^S_{j,t+1}$, $j = 1, 2, ..J_S$.

Proposition 2 *Stock returns satisfy the following conditions*

$$\mathrm{E}_t(M_{t,t+1}R^S_{t+1}) = 1 \tag{14}$$

$$R^I_{t+1} = \omega_t R^S_{t+1} + (1 - \omega_t)R^B_{t+1} \tag{15}$$

where $(1 - \omega_t)$ *is the leverage ratio.*

Proof See Appendix A ■

Although the proof is somewhat elaborate, equation (15) merely states that stock returns are a weighted average of investment and bond returns. Given (15) and (13) it is immediate to verify that stock returns must satisfy the moment condition (14).

Equations (13)-(15) offer two alternative ways to examine the asset pricing implications of financing frictions. While the identity (15) focuses on *ex-post* returns, the Euler equations (13) and (14) are about *expected* returns. Thus, while firm specific risks may play an important role in examining the former, for the latter only systematic risk is relevant.

In Gomes, Yaron, and Zhang (2002) we investigate the importance of these idiosyncratic components using firm level data. Here, we concentrate on the role financing frictions play in pricing the cross-section of *expected* returns, by focusing only on aggregate factors. Specifically then, we use a pricing kernel that depends only on the returns to aggregate investment and a bond index:

$$M_{t,t+1} = l_0 + l_1 R^I_{t+1} + l_2 R^B_{t+1}, \tag{16}$$

a specification that only requires individual returns to be approximately linear in aggregate returns.[8] In the context of production based asset pricing this approach seems a reasonable first step. Cross-sectional variations in firms's investment opportunities may be important in pricing asset returns only to the extent that they affect some aggregate systematic risk. Unlike the consumption-based literature on asset pricing, where the use of the cross-sectional distribution was motivated by the lack of success of aggregate consumption-based models (see Constantinides and Duffie (1996)), aggregate investment returns actually work very well in pricing the cross-section of returns (Cochrane (1996)); thus, the scope for firm heterogeneity affecting the systematic risk for financial distress seems fairly limited.[9]

As we can see from (12), information about the degree of financial frictions is contained in investment returns, which will then serve as a factor capturing the extent to which aggregate financial conditions are priced. In this sense, our formulation is essentially a structural version of an APT-type framework in which one of the factors proxies for an aggregate distress variable (and where different portfolios have varying loading on this factor), such as that taken in Fama and French (1993,1996) and Lamont, Polk, and Saá-Requejo (2000).

In essence, our metric for evaluating whether financing frictions are important is whether they show as a systematic risk for the cross section of returns. This seems a natural benchmark from the standpoint of asset pricing.

[8]From Harrison and Kreps (1979) and Hansen and Richard (1987) we know that one pricing kernel that satisfies (13) is $M_{t,t+1} = \sum_j l_j R_j^S + \sum_n l_n R_n^I + \sum_l l_l R_l^B$. Stock returns can be eliminated since (15) implies that only two of these returns are independent. For using aggregate investment return, we formally only need that $R_{d,t+1}^I \approx \gamma_d^0 + \gamma_d^1 R_{t+1}^I + \epsilon_{d,t+1}$ for portfolio d and the $\epsilon_{d,t+1}$ be *i.i.d.* This is only a statement about technologies and not about market completeness, and it appears reasonable provided that the level of portfolio disaggregation is not too fine, as will be the case.

[9]It is important to note, however, that, in principle, there is no problem in modifying our approach to include measures of cross-section variation across firms in the pricing kernel, by adding more disaggregated investment returns. For example, Li, Vassalou and Xing (2001) study the effects of cross-sectional variation by including investment growth in five separate sectors in their construction of the pricing kernel.

3.2 Econometric Methodology

Our estimation strategy allows us to estimate factor loadings, $\mathbf{l}$, as well as the parameters, a and b, by utilizing M as specified in (16) in conjunction with moment conditions (13).

We follow Cochrane's (1996) estimation techniques for assessing the asset pricing implications of our model. Specifically, three alternative sets of moment conditions in implementing (13) are examined. First, we look at the relatively weak restrictions implied by the unconditional moments. We then focus on the conditional moments by scaling returns with instruments, and finally we look at time variation in the factor loadings, by scaling the factors.

For the unconditional factor pricing we apply standard GMM procedures to estimate the cost parameters, a and b, and loading factors, $\mathbf{l}$, by simply minimizing a weighted average of the sample moments (13). Letting $\sum_T$ denote the sample mean, we can rewrite these moments, $\mathbf{g}_T$ as:

$$\mathbf{g}_T \equiv \mathbf{g}_T(a, b, \mathbf{l}) \equiv \textstyle\sum_T \left[M\mathbf{R} - \mathbf{p}\right]$$

where $\mathbf{R} = [R^S, R^I(\mathbf{y}; a, b), R^B]$ is the menu of asset returns being priced, $\mathbf{p} = [\mathbf{1}, 1, 1]$ is a vector of prices, and $\mathbf{y} = (i, \pi, DF)$. One can then choose $(a, b, \mathbf{l})$ to minimize a weighted sum of squares of the pricing errors across assets:

$$J_T = \mathbf{g}_T' \mathbf{W} \mathbf{g}_T \tag{17}$$

A convenient feature of our setup is that given a and b, the criterion function above is linear in $\mathbf{l}$ — the factor loading coefficients. Standard χ^2 tests of over-identifying restrictions follow from this procedure. This also provides a natural framework to assess whether the loading factors or technology parameters are important for pricing assets. Note that the investment return appears both in the pricing kernel and the menu of assets being priced. As Cochrane (1996) notes, this consistency is required so that investment returns do not have arbitrary properties.

It is straightforward to include the effects of conditioning information by scaling the returns and/or scaling the factors by instruments. The essence of this exercise lies in extracting the conditional implications of (13) since, for a time-varying conditional model, these implications may not be well captured by a corresponding set of unconditional moment restrictions as was noted by Hansen and Richard (1987).

To test conditional predictions of (13), we expand the set of returns to include returns scaled by instruments to obtain the moment conditions:

$$\mathrm{E}\left[\mathbf{p}_t \otimes \mathbf{z}_t\right] = \mathrm{E}\left[M_{t,t+1}\left(\mathbf{R}_{t+1} \otimes \mathbf{z}_t\right)\right]$$

where $\mathbf{z}_t$ is some instrument in the information set at time t and $\otimes$ denotes the Kronecker product.

A more direct way to extract the potential non-linear restrictions embodied in (13) is to let the stochastic discount factor be a linear combination of factors with weights that vary over time. That is, the vector of factor loadings $\mathbf{l}$ is a function of instruments $\mathbf{z}$ that vary over time.[10] Therefore, to estimate and test a model in which factors are expected to price assets only conditionally, we simply expand the set of factors to include factors scaled by instruments. The stochastic discount factor utilized in estimating (13) is then,

$$M_{t,t+1} = \left[l_0 + l_1 R^I_{t+1} + l_2 R^B_{t+1}\right] \otimes z_t$$

[10] With sufficiently many powers of $z's$ the linearity of l can actually accommodate nonlinear relationships.

3.3 Data

This section provides an overview of the data used in our study. A more detailed description is provided in Appendix B. Our data for the economic aggregates comes from NIPA and the Flow of Funds Accounts. Information about financial assets is obtained from CRSP and Ibbotson. The construction of investment returns requires data on profits, investment and capital. Capital consumption data is used to compute the time series average of the depreciation rate and pin down the value of δ, the only technology parameter that we do not formally estimate. To avoid measurement problems due to chain weighting in the earlier periods our sample starts in the first quarter of 1954 and ends in the last quarter of 2000. Since models of financing frictions are usually applied to non-financial firms we first construct series on investment, capital and profits of the Non-Financial Corporate Sector. For comparison purposes, we also report results for the aggregate economy. Investment data are quarterly averages, while asset returns are from the beginning to the end of the quarter. As a correction, we follow Cochrane (1996) and average monthly asset returns over the quarter and then shift them so they go from approximately the middle of the initial quarter to the middle of the next quarter.[11]

In order to implement the estimation procedure, we require a sufficient number of moment conditions. As described above, we limit ourselves to examining the model's implications for aggregate investment and bond returns. This means that we need to look at more than just the aggregate stock return. Thus, we focus on the ten size portfolios of NYSE stocks. Table 1 reports the summary statistics of these asset returns. In addition, we also provide results for the 25 Fama and French (1993) size and book-to-market portfolio returns. Bond data comes from Ibbotson's index of Long Term Corporate Bonds. The default premium

[11] See also Lamont (2001) and Lettau and Ludvigson (2001) for a discussion of the important consequences of aligning investment and asset returns.

is defined as the difference between the yields on AAA and BAA corporate bonds, both obtained from DRI.

Conditioning information comes from two sources: the term premium, defined as the yield on ten year notes minus that on three-month Treasury Bills, and the dividend-price ratio of the equally weighted NYSE portfolio. We follow Cochrane (1996) and limit the number of moment conditions and scaled factors in three ways: (i) we do not scale the Treasury-Bill return by the instruments since we are more interested in the time-variation of risk premium than that of risk-free rate. (ii) Instruments themselves are not included as factors. (iii) We use only deciles one, two, five, and ten in the conditional estimates.

4 Results

4.1 GMM Estimates

Table 2 reports iterated GMM estimates for the unconditional, conditional, and scaled models. First-stage estimates are very similar, particularly those concerning the role of financing costs. In all cases we report the value of the parameters a and b as well as the estimated loadings $\mathbf{l}$ and corresponding t-statistics. Also included are the results of J tests on the model's overall ability to match the data, the corresponding p-values, and the root mean square (RMSE) of the pricing errors, α — mean return less predicted mean return.

Our model is quite successful at pricing the cross-section of returns. In spite of the inclusion of the last few years of stock market data, the model cannot be rejected using the overidentifying restriction tests, J_T. The root mean squared errors are all low (in particular when we use both investment and bond returns as pricing factors) — suggesting the statistical significance of the J tests is not due to an excessively large covariance matrix.[12] This is

[12]RMSE (α) are actually cut in half if we truncate our sample in 1997.

verified by Figure 1 that plots predicted versus actual mean excess returns from first stage estimation, and it clearly displays the goodness of fit of the model. In addition, the hypothesis that all factor loadings are zero is almost always rejected at the standard 5% significance level.

Although our model uses only a single aggregate investment return as a pricing factor (in addition to the corporate bond return) these results are generally comparable to Cochrane's (1996) findings. The reason for this empirical success is that our construction of investment returns, R^I, uses independent information on variations in the marginal productivity of capital, π_t, and investment, i_t. Cochrane (1996) on the other hand, abstracts from the variation in the marginal productivity of capital in constructing investment returns and hence uses two separate investment series (residential and non-residential) to construct two investment returns.[13]

Although our model requires the use of two pricing factors (R^I and R^B), our results are essentially the same whether or not we use bond returns as a pricing factor. The estimated loadings on the corporate bond returns are also statistically insignificant, suggesting that their role in pricing financial assets is fairly minor.

4.2 The Effect of Financing Constraints

The focus of our analysis, however, is the role of the financing cost parameter b. Here the message from all panels is very clear. In all cases the actual point estimate of b is exactly zero![14]

Why are the financing constraints not useful in pricing the cross-section of expected returns? Alternatively, why do they seem irrelevant for the construction of the stochastic

[13]Economically, our estimates for a are also quite sensible, since the implied adjustment costs are about 8-9% of total investment spending, which is comparable to Cochrane's (1996) estimate.

[14]Note that since costs can not be negative, values of a or b below zero are not admissible.

discount factor? The answer lies in the countercyclical properties of the premium on external finance.

4.2.1 The Financing Premium

To gain some intuition on the role of the financing frictions on the pricing kernel, consider their impact on investment returns by decomposing (12) as:

$$R^I_{t+1} \approx \frac{1 + b(X_{t+1})}{1 + b(X_t)} \hat{R}^I \tag{18}$$

where $\hat{R}^I$ denotes investment returns with no financing costs. Loosely, this return summarizes the effects of the fundamentals, and is determined by the cyclical properties of both profits and physical investment. The role of the financing frictions is captured by $\frac{1+b(X_{t+1})}{1+b(X_t)}$.

Figure 2 displays the correlation structure between DF_{t+1}/DF_t, $\hat{R}^I_{t+1}$, R^I_{t+1} with a positive b, and R^S_{t+1}, with leads and lags of i_t (Panel A) and π_t (Panel B). The pattern is striking. In both cases, the pattern of $\hat{R}^I$ is very similar to that of observed R^S. Both returns *lead* future economic activity, while their contemporaneous correlation with fundamentals is somewhat low. As Cochrane (1991) notes, this is to be expected if firms adjust current investment in response to an anticipated rise in future productivity.

The behavior of the default premium, however, is quite different. Its negative correlation with future economic activity implies a series of investment returns that behaves much less like the observed stock returns, thus straining the ability of R^I_{t+1}, inclusive of financing constraints, to be a useful pricing factor.

Alternatively, since a rise in expected future productivity (or profits) is associated with an expected decline in the financing premia (because of its counter-cyclical properties), there is an incentive for the firm to delay its investment response in the presence of financing constraints. From equation (12) we learn that this lowers investment returns. Given the observed pattern of stock returns in the data this leads to a lower correlation between investment and stock returns.

To summarize, productivity and financing costs provide two competing forces that determine the reaction of investment, and hence investment returns, to business cycle conditions. Productivity implies that firms should respond by investing immediately. On the other hand, since the future entails lower financing costs firms should delay investment. Figure 2 shows that consistency with asset return data requires the financing channel to be unimportant.

Figure 2 also suggests that these results are not likely to rely on timing issues such as those created by the existence of time to plan (or perhaps time to finance in this context), since there is no obvious phase shift between the premium and the return series.

What seems crucial is the countercyclical pattern of the premium on external finance, induced by the behavior of the default premium. However almost any realistic measure of the cost of external finance would exhibit this same countercyclical pattern, with costs increasing in relatively bad times. Thus, while our measure of financing costs as propotional to the default premium might be something of an oversimplification, particularly in the case of equity, our conclusions are likely to be robust to alternative measures.

4.2.2 Limitations of Reduced Form Analysis

It is important to point out the benefits of imposing in our estimation strategy the theoretical restrictions implied by our structural approach. An alternative and common approach is simply to allow for some measure of financial distress (say F_{t+1}) to appear as a factor in an APT-like model. An example would be to model the pricing kernel as $M_{t+1} = l_0 + l_1 R_{m,t+1} + l_2 F_{t+1}$, without any restriction on the sign and magnitude of l_2. The fact that financing frictions appear explicitly as costs in our framework requires that $b \geq 0$, since costs can not be negative. Ignoring this restriction by allowing $b < 0$ also reverses the countercyclical properties of the financing costs, a feature that would enhance the correlation between the return on investment and profits. This in turn would lead one to conclude that financing frictions are relevant for pricing assets without realizing that it implies negative financing costs.

4.2.3 The Pricing Kernel

Financing frictions obviously change the dynamics of the pricing kernel. Table 3 shows a few statistical measures of the way these frictions influence the pricing kernel and pricing errors. It describes the effects of increasing the value of b in each set of moment conditions, while a is kept constant at its optimal level reported in columns 5–7 of Table 2.

As we can readily observe, the presence of financing constraints effectively lowers the market price of risk $\sigma(M)/E(M)$, as well as the (absolute) correlation between the pricing kernel and value-weighted returns for all three models, thus deteriorating the performance of the pricing kernel. Perhaps more direct evidence is given by examining the implied pricing errors. A simple way of doing this is to compute the beta representation:

$$R_i - R_f = \alpha_i + \beta_{1i}(R^I - R_f) + \beta_{2i}(R^B - R_f)$$

Given the assumed structure of the pricing kernel this representation exists, with $\alpha_i = 0$ (see discussion in Cochrane (2001)). Therefore, large values of α are evidence against the model. Table 3 reports the implied αs for the regressions on both decile 1 (small firms) and value-weighted returns. It displays a clear pattern of increasing α as we increase the magnitude of the financing costs. Indeed, while we cannot reject that $\alpha = 0$ when $b = 0$, this hypothesis is rejected for most of the other parameter configurations.

We also report the implications of financing costs for the raw moments of investment returns and their correlation with market returns. While both the mean and the variance of investment returns are not changed by much as b increases (at least initially), the main implication of increasing financing constraints is to lower their correlation with asset returns. Since the overall performance of a factor model hinges on its covariance structure with returns, it is not surprising that financing costs are not important for the construction of the pricing kernel as documented in Table 2.[15]

5 Robustness

This section examines the robustness of our results by exploring several alternatives to our benchmark approach.

5.1 Small Firms Effects

Several studies on firm financing constraints emphasize that they are more likely to be detected when looking only at the behavior of small firms. An easy way to assess the model's implications for different firms is to test the moment conditions (13) for portfolios of small firms only. We investigate this possibility in Table 4. We have also included are the χ^2-statistics and corresponding p-values for the relevant Wald tests when our estimate of b is non-zero. As columns 2–4 show, we cannot find any evidence for a significant role of financing frictions, even in this case. Even when b is slightly positive, the hypothesis that it is statistically zero can be rejected only at extremely high significance levels.

[15] An alternative way of representing the impact of financing constraints is to compare their effect on the pricing kernels with the Hansen-Jagannathan (1991) bounds. Increasing b has the effect of moving the estimated kernels farther way from the bounds.

5.2 Fama-French Portfolios

Several authors interpret the cross-sectional variation in the Fama and French (1993) size and book-to-market portfolio returns as proxies for some measure of relative financial distress. Columns 5–7 in Table 4 report the results when our model is used to price the 25 Fama and French (1993) portfolio returns. However, the estimated value of b is zero, again suggesting that financing frictions do not play a crucial role in determining the cross-section of returns.

5.3 Different Macroeconomic Data

Table 5 shows the effects of using alternative data in the construction of the investment returns. Columns 2–4 report the results of using after tax profits in the construction of investment returns, while columns 5–7 report similar results when data on overall macroeconomic aggregates is used. It is easy to see that these alternative constructions have no impact on our main conclusions from Table 2.

5.4 Non-Linear Pricing Kernels

The use of a linear factor representation may be restrictive, and several alternative approaches modelling nonlinear pricing kernels have been recently advanced in the literature.[16] We explore this possibility by re-estimating the moment conditions using several nonlinear pricing kernels. Specifically, we consider examples where the pricing kernel is quadratic in either R^I alone or in both R^I and R^B. Again, as columns 2–7 in Table 6 show, none of these cases reveals any evidence for financing costs.

[16]E.g., Bansal and Vishwanathan (1993), Chapman (1997), and Brandt and Yaron (2001).

5.5 Alternative Cost Functions

While our financing cost function is derived from first principles, given our model's assumptions, we can also apply our methodology to investigate the consequences of using alternative, less structural, functional forms. While these may not correspond exactly to the underlying constrained problem in (3), they may nevertheless provide a useful approximation for empirical purposes.

In this section we explore the implications of a simple alternative characterization of the cost function:

$$(b \times DF_t \times E_t) \times E_t = b \times DF_t \times E_t^2,$$

where the term $b \times DF_t \times E_t$ now captures the premium which multiplies external finance, E_t. Quadratic cost functions of this form correspond to some popular models of financing frictions, such as that in Stein (2001). Intuitively they correspond to the assumption that the premium on external finance, $b(\cdot)$, is linear in the amount of external finance raised.

Columns 8–10 in Table 6 confirm that this modification has a negligible impact on our results. Even when the actual point estimate of b is not exactly zero, the hypothesis that it differs from zero is easily rejected.

6 Conclusion

Despite its empirical success, the production based asset pricing model (Cochrane (1991, 1996)) has been, until recently, relatively neglected by researchers, in favor of either standard consumption based or APT-like asset pricing models. This is unfortunate since, by concentrating on optimal firm behavior, this approach holds the promise of endogenously linking firm characteristics with asset returns. Moreover, it also provides a natural way of integrating new developments in the theory of corporate finance into an asset pricing framework.

In this paper we pursue this line of research by incorporating costly external finance in a production based asset pricing model and ask whether financing frictions help in pricing the cross-section of expected returns. To avoid specifying the underlying source of these frictions we show that the typical assumptions about the nature of the financing frictions are captured by a simple "financing cost" function, which provides a tractable framework to examine the role of financing frictions in pricing asset returns.

Our empirical findings suggest that the role played by financing frictions is fairly negligible, unless the premium on external funds is procyclical, a property not evident in the data and not satisfied by most models of costly external finance. This finding is robust to several alternative formulations of our model, particularly the form of the financing cost function, the specific macroeconomic data used, and the set of returns used in our GMM implementations.

These findings question whether financing frictions are important for explaining the cross-section of returns and for determining investment behavior. Moreover, our results also cast doubt on whether financing constraints provide a realistic propagation mechanism in several macroeconomic models.

A few aspects of our empirical implementation suggest promising directions for future research. First, investment may have an important time-to-build component, and financing procedures may precede the actual investment spending by a quarter or more, leading firms to look at lagged measures of fundamentals when making their decisions. Although our results suggest that this explanation is unlikely to account for the rejection of financing frictions, only an explicit examination of the potential time aggregation implications can formally address this issue. Second, although financing constraints seem to play no role in determining the *portfolio* returns in this paper, they may still be fairly important at the individual firm level. Since our model holds for every firm it can also be used to investigate this issue by looking directly at firm level implications as well.

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A Proofs

To prove Proposition 1 we need to establish the following Lemma first.

Lemma 1 *When debt is positive, the multiplier μ_t satisfies the following conditions:*

$$\frac{\partial \mu_t}{\partial K_t} = \frac{\partial \mu_t}{\partial B_t} = 0$$

Proof. The envelope conditions for respect to K_t and B_t imply:

$$\begin{aligned}
V_{21}(K_t, B_t, X_t) &= -\frac{\partial \mu_t}{\partial K_t}\left[R(B_t/K_t) + R_1(B_t/K_t)(B_t/K_t)\right] \\
&\quad +\mu_t\left[R_1(B_t/K_t)(2B_t/K_t^2) + R_{11}(B_t/K_t)(B_t^2/K_t^3)\right] \qquad \text{(A1)} \\
V_{22}(K_t, B_t, X_t) &= -\frac{\partial \mu_t}{\partial B_t}\left[R(B_t/K_t) + R_1(B_t/K_t)(B_t/K_t)\right] \\
&\quad -\mu_t\left[R_1(B_t/K_t)(2/K_t) + R_{11}(B_t/K_t)(B_t/K_t^2)\right]
\end{aligned}$$

Now homogeneity of the value function implies that

$$\begin{aligned}
0 &= V_{21}(K_t, B_t, X_t)K_t + V_{22}(K_t, B_t, X_t)B_t \\
&= -\left[R(B_t/K_t) + R_1(B_t/K_t)(B_t/K_t)\right]\left(\frac{\partial \mu_t}{\partial K_t}K_t + \frac{\partial \mu_t}{\partial B_t}B_t\right)
\end{aligned}$$

thus confirming that μ_t is indeed homogeneous of degree zero in K_t and B_t.

Now since

$$\begin{aligned}
V_{21}(K, B, X) &= V_{12}(K, B, X) = \frac{\partial \mu_t}{\partial B_t}\left[C_1(K_t, K_{t+1}, X_t) + R_1(B_t/K_t)(B_t/K_t)^2\right] \\
&\quad +\mu_t\left[R_1(B_t/K_t)(2B_t/K_t^2) + R_{11}(B_t/K_t)(B_t^2/K_t^3)\right] \qquad \text{(A2)}
\end{aligned}$$

equating (A1) and (A2) and simplifying yields

$$-\frac{\partial \mu_t}{\partial K_t}\left[R(B_t/K_t) + R_1(B_t/K_t)(B_t/K_t)\right] = \frac{\partial \mu_t}{\partial B_t}\left[C_1(K_t, K_{t+1}, X_t) + R_1(B_t/K_t)(B_t/K_t)^2\right]$$

Thus,

$$\frac{\partial \mu_t}{\partial K_t}R(B_t/K_t) + \frac{\partial \mu_t}{\partial B_t}C_1(K_t, K_{t+1}, X_t) = \left(\frac{\partial \mu_t}{\partial K_t}K_t + \frac{\partial \mu_t}{\partial B_t}B_t\right)R_1(B_t/K_t)(B_t/K_t^2) = 0$$

Therefore, the derivatives of μ_t satisfy the following two conditions

$$\begin{aligned}
\frac{\partial \mu_t}{\partial K_t}R(B_t/K_t) + \frac{\partial \mu_t}{\partial B_t}C_1(K_t, K_{t+1}, X_t) &= 0 \\
\left(\frac{\partial \mu_t}{\partial K_t}K_t + \frac{\partial \mu_t}{\partial B_t}B_t\right) &= 0
\end{aligned}$$

But since $B_t > 0$

$$R(B_t/K_t)B_t + C_1(K_t, K_{t+1}, X_t)K_t > 0$$

and we must have that

$$\frac{\partial \mu_t}{\partial K_t} = \frac{\partial \mu_t}{\partial B_t} = 0$$

■

Proof of Proposition 1. In the case of debt financing only, investment returns can be written as:

$$R^I_{t+1} = \frac{\mu_{t+1}\left[C_1(K_{t+1}, K_{t+2}, X_{t+1}) + R_1(B_{t+1}/K_{t+1})(B_{t+1}/K_{t+1})^2\right]}{-\mu_t C_2(K_t, K_{t+1}, X_t)} \tag{A3}$$

Define the function:

$$G(K_t, K_{t+1}, X_t) = (\mu_t - 1)B_{t+1} \tag{A4}$$

it follows that

$$G_1(K_t, K_{t+1}, X_t) = -(\mu_t - 1)\left[C_1(K_t, K_{t+1}, X_t) + R_1(B_t/K_t)(B_t/K_t)^2\right] \tag{A5}$$

$$G_2(K_t, K_{t+1}, X_t) = -(\mu_t - 1)C_2(K_t, K_{t+1}, X_t) \tag{A6}$$

Integration of (A6) yields

$$G(K_t, K_{t+1}, X_t) = \int G_2(K_t, K_{t+1}, X_t)\, dK_{t+1} = -(\mu_t - 1)C(K_t, K_{t+1}, X_t) + f_1(K_t, X_t)$$

where $f_1(\cdot)$ is independent of K_{t+1}. Using Lemma 1 we know that the integral of (A5) equals

$$G(K_t, K_{t+1}, X_t) = -(\mu_t - 1)C(K_t, K_{t+1}, X_t) - (\mu_t - 1)\int R_1(B_t/K_t)(B_t/K_t)^2\, dK_t + f_2(K_{t+1}, X_t)$$

where $f_2(\cdot)$ is independent of K_t. Combining two equations above yields

$$G(K_t, K_{t+1}, X_t) = (\mu_t - 1)\left[R(B_t/K_t)B_t + \overline{D} - C(K_t, K_{t+1}, X_t)\right] = (\mu_t - 1)B_{t+1}$$

where the second equality follows from (4) and the fact that $B_t > 0 \Longrightarrow D_t = \overline{D}$. Equation (A3) now implies that:

$$R^I_{t+1} = \frac{C_1(K_{t+1}, K_{t+2}, X_{t+1}) - G_1(K_{t+1}, K_{t+2}, X_{t+1})}{-C_2(K_t, K_{t+1}, X_t) + G_2(K_t, K_{t+1}, X_t)} = \frac{\widetilde{C}_1(K_{t+1}, K_{t+2}, X_{t+1})}{-\widetilde{C}_2(K_t, K_{t+1}, X_t)}$$

■

To prove Proposition 2 we need to establish the following Lemma first.

Lemma 2 *The value of the firm equals the sum of (cum-dividend) equity value and the value of outstanding debt:*

$$q_t K_t = V(K_t, B_t, X_t) + \mu_t B_t\left[R(B_t/K_t) + R_1(B_t/K_t)\,(B_t/K_t)\right] \tag{A7}$$

where $q_t = V_1(K_t, B_t, X_t)$ denotes the marginal q. Moreover, (A7) implies that marginal q equals Tobin's (average) q.

Proof For simplicity consider the case where $\overline{D} = 0$. Rewrite the value of the firm as

$$V(K_t, B_t, X_t) = \max_{\substack{D_t, B_{t+1}, \\ K_{t+1}, N_t}} \left\{ \begin{array}{c} (1 - \mu_t + \lambda_t^d)D_t + [\mu_t - W(N_t/K_t) + \lambda_t^n]N_t + \mu_t[C(K_t, K_{t+1}, X_t) \\ +B_{t+1} - R(B_t/K_t)B_t] + \mathrm{E}_t\left[M_{t,t+1}V(K_{t+1}, B_{t+1}, X_{t+1})\right] \end{array} \right\}$$

The complementarity-slackness conditions imply that the first term on the right-hand side is zero and the second equals $W_1(N_t/K_t)(N_t/K_t)N_t$.

Next, homogeneity of the value function and the envelope conditions imply that:

$$\mathrm{E}_t\left[M_{t,t+1}V(K_{t+1}, B_{t+1}, X_{t+1})\right] = -\mu_t C_2(K_t, K_{t+1}, X_t)K_{t+1} - \mu_t B_{t+1}$$

while homogeneity of C yields

$$C_1(K_t, K_{t+1}, X_t)K_t = C(K_t, K_{t+1}, X_t) - C_2(K_t, K_{t+1}, X_t)K_{t+1}$$

Hence the value function collapses to

$$V(K_t, B_t, X_t) = W_1(N_t/K_t)(N_t/K_t)N_t + \mu_t\left[C_1(K_t, K_{t+1}, X_t)K_t - R(B_t/K_t)B_t\right]$$

Rearranging, and using the envelope condition, we have:

$$V(K_t, B_t, X_t) + \mu_t\left[R(B_t/K_t)B_t + R_1(B_t/K_t)(B_t/K_t)B_t\right] = V_1(K_t, B_t, X_t)K_t$$

■

Proof of Proposition 2. By definition stock returns are given by

$$R_{t+1}^S = \frac{V^e(K_{t+1}, B_{t+1}, X_{t+1}) + [D_{t+1} - W(N_{t+1}/K_{t+1}, X_{t+1})N_{t+1}]}{V^e(K_t, B_t, X_t)}, \tag{A8}$$

where

$$V^e(K_t, B_t, X_t) \equiv V(K_t, B_t, X_t) - [D_t - W(N_t/K_t, X_t)N_t] \tag{A9}$$

is the (current period) value of the firm to shareholders after new issues take place and dividends are paid.

Again consider the simple case where $\overline{D} = 0$. Starting from the definition of investment returns (12), we have

$$\begin{aligned} R^I &= \frac{V_1(K_{t+1}, B_{t+1}, X_{t+1})}{-\mu_t C_2(K_t, K_{t+1}, X_t)} = \frac{V_1(K_{t+1}, B_{t+1}, X_{t+1})}{\mu_t\left[C_1(K_t, K_{t+1}, X_t)K_t - C(K_t, K_{t+1}, X_t)\right]} && \text{(A10)} \\ &= \frac{V(K_{t+1}, B_{t+1}, X_{t+1}) + \mu_{t+1}B_{t+1}\left[R(B_{t+1}/K_{t+1}) + R_1(B_{t+1}/K_{t+1})(B_{t+1}/K_{t+1})\right]}{V(K_t, B_t, X_t) - \mu_t D_t + \mu_t B_{t+1} + N_t\left[\mu_t - W_1(N_t/K_t)(N_t/K_t)\right]} && \text{(A11)} \end{aligned}$$

where the second equality follows from homogeneity of $C(\cdot)$, and the third from the envelope condition and Lemma 2. Next, observe that the complementarity slackness conditions imply:

$$D_t(1-\mu_t) = 0$$
$$N_t[\mu_t - W_1(N_t/K_t)(N_t/K_t)] = W(N_t/K_t)N_t$$

Thus

$$R^I_{t+1} = \frac{V(K_{t+1}, B_{t+1}, X_{t+1}) + \mu_{t+1}B_{t+1}\left[R(B_{t+1}/K_{t+1}) + R_1(B_{t+1}/K_{t+1})(B_{t+1}/K_{t+1})\right]}{V(K_t, B_t, X_t) - D_t + \mu_t B_{t+1} + W(N_t/K_t)N_t}$$

Using the definitions of R^S_{t+1}, R^B_{t+1} it follows that:

$$R^I_{t+1} = (1-\omega_t)R^S_{t+1} + \omega_t R^B_{t+1}$$

where the leverage ratio, ω_t, equals

$$\omega_t = \frac{\mu_t B_{t+1}}{V^e(K_t, B_t, X_t) + \mu_t B_{t+1}}. \tag{A12}$$

With this result established, it follows immediately that

$$1 = \mathrm{E}_t\left[M_{t,t+1}R^S_{t+1}(1-\omega_t)\right] + \mathrm{E}_t\left[M_{t,t+1}R^B_{t+1}\omega_t\right] = (1-\omega_t)\mathrm{E}_t\left[M_{t,t+1}R^S_{t+1}\right] + \omega_t$$

or, simply

$$\mathrm{E}_t\left[M_{t,t+1}R^S_{t+1}\right] = 1 \tag{A13}$$

■

B Data Construction

Macroeconomic data comes from NIPA, published by the BEA, and the Flow of Funds Accounts, available from the Federal Reserve System. These data are cross-referenced and mutually consistent, so they form, for practical purposes, a unique source of information. Most of our experiments use data for the Nonfinancial Corporate Sector. Specifically Table F102 is used to construct measures of profits before (item FA106060005) and after tax accruals (item FA106231005). To these measures we add both consumption capital (item FA106300015) and inventory valuation (item FA106020601) adjustments to obtain a better indicator of actual cash flows. Investment spending is gross investment (item 105090005). The capital stock comes from Table B102 (Item FL102010005). Since stock valuations include cash flows from operations abroad, we also include in our measures of profits the value of foreign earnings abroad (item FA266006003) and that of net foreign holdings to the capital stock (items FL103092005 minus FL103192005, from Table L230) and investment (the change in net holdings). Financial liabilities come also from Table B102. They are constructed by subtracting financial assets, including trade receivables, (Item FL104090005) from liabilities in credit market instruments (Item FL104104005) plus trade payables (Item FL103170005). Interest payments come from NIPA Table 1.16, line 35. All these are available at quarterly frequency and require no further adjustments. Series for the aggregate economy come from NIPA.

Financial data come from CRSP and Ibbotson. We use the ten size portfolios of NYSE stocks

(CRSP series DECRET1 to DECRET10). Corporate bond data comes from Ibbotson's index of Long Term Corporate Bonds. The default premium is defined as the difference between the yields on AAA and Baa corporate bonds, from CRSP. Term premium, defined as the yield on 10 year notes minus that on three-month Treasury bills, and the dividend-price ratio of the equally weighted NYSE portfolio (constructed from CRSP EWRETD and EWRETX).[17]

Table 1 : Summary Statistics of the Assets Returns in GMM

This table reports the means, volatilities, Sharpe ratios, and first-order autocorrelations of excess returns of deciles 1–10, excess value-weighted market return (*vwret*), real t-bill rate (R^F), and corporate bond return (R^B). These returns are used in GMM estimation and tests. The sample period is from 1954:2Q to 2000:3Q. Means and volatilities are in annualized percent.

	Decile Returns										vwret	R^F	R^B
	1	2	3	4	5	6	7	8	9	10			mean
mean	11.80	9.49	9.03	9.07	8.50	8.57	7.67	8.16	7.34	6.64	7.10	1.86	0.51
std	19.61	17.49	16.73	16.16	15.49	15.19	14.51	13.80	12.90	11.35	11.87	1.32	7.23
Sharpe	0.60	0.54	0.53	0.55	0.54	0.56	0.52	0.58	0.56	0.57	0.58	0.00	0.09
$\rho(1)$	0.26	0.29	0.29	0.31	0.29	0.28	0.32	0.27	0.27	0.36	0.33	0.67	0.29

[17]Dividend-price ratios are also normalized so that scaled and non-scaled returns are comparable.

Table 2 : GMM Estimates and Tests — The Benchmark

This table reports GMM estimates and tests of the benchmark model with linear G function where $b_t = b \times \mathrm{DF}_t$ and DF_t is the default premium. Investment return series are constructed from flow of funds accounts using nonfinancial profits before tax. T-statistics are reported in parentheses to the right of parameter estimates. Finally, we also report the root mean square pricing error α — mean return less predicted mean return — in percentage per quarter, where pricing errors are calculated as $\alpha_j = 100 \times \mathrm{E}[MR_j - p_j]/\mathrm{E}[M]$, the χ^2 statistic and corresponding p-value for the J_T test on over-identification, and p-values of the Wald test on the null hypothesis that $a = 0$. We conduct GMM estimates and tests for the unconditional model, unscaled and scaled conditional model, for both one-factor and two-factor specifications of the pricing kernel. The unconditional model uses as moment conditions the excess returns of 10 CRSP size decile portfolio and one investment return and the real Treasury-bill return (12 moment conditions). The unscaled and scaled conditional models use the deciles 1, 2, 5, 10, and investment returns, scaled by instruments, and the real Treasury-bill return (16 moment conditions). Instruments are the constant, term premium (tp), and equally weighted dividend-price ratio (dp). So the scaled factor model in the one-factor case features pricing kernel $M = l_0 + l_1 R^I + l_2(R^I \cdot tp) + l_3(R^I \cdot dp)$ and in the two-factor case $M = l_0 + l_1 R^I + l_2 R^B + l_3(R^I \cdot tp) + l_4(R^I \cdot dp) + l_5(R^B \cdot tp) + l_6(R^B \cdot dp)$.

	One Factor Model						Two Factor Model					
	Unconditional		Conditional		Scaled Factor		Unconditional		Conditional		Scaled Factor	
						Parameters						
a	9.63	(3.98)	8.42	(6.16)	8.90	(4.93)	13.65	(2.30)	9.71	(3.88)	8.79	(4.41)
b	0.00		0.00		0.00		0.00		0.00		0.00	
						Loadings						
l_0	60.50	(1.83)	108.79	(4.29)	96.13	(3.32)	55.02	(1.64)	103.01	(3.41)	89.68	(2.52)
l_1	-58.65	(-1.81)	-106.16	(-4.26)	-93.52	(-3.27)	-41.94	(-1.30)	-90.43	(-2.77)	-109.65	(-3.11)
l_2					-0.19	(-1.13)	-11.40	(-1.92)	-10.11	(-1.52)	23.10	(1.73)
l_3					0.08	(0.48)					9.81	(3.29)
l_4											6.37	(1.01)
l_5											-10.28	(-3.36)
l_6											-6.40	(-0.98)
						Root Mean Squared Pricing Error						
α	1.15		2.13		0.45		0.30		0.67		0.33	
						J_T Test						
χ^2	14.01		18.62		16.55		8.27		15.60		8.20	
p	0.08		0.10		0.08		0.31		0.16		0.32	

Table 3 : Properties of Pricing Kernels, Jensen's α, and Investment Returns

This table reports, for each combination of parameters a and b, properties of the pricing kernel, including market price of risk ($\sigma[M]/\mathrm{E}[M]$), the contemporaneous correlation between pricing kernel and real market return (ρ_{M,R^S}), Jensen's α and its corresponding t-statistic (t_α), summary statistics of investment return, including mean, volatility (σ_{R^I}), first-order autocorrelation ($\rho(1)$), and correlation with the real value-weighted market return (ρ_{R^I,R^S}). Jensen's α is defined from the following regression: $R^p - R^f = \alpha + \beta_1(R^I - R^f) + \beta_2(R^B - R^f)$ where R^p is either real value-weighted market return (R^{vw}) or real decile one return (R^1), R^f is real interest rate proxied by real treasury-bill rate, R^I is investment return, and R^B is real corporate bond return. In each case the cost parameters a's are held fixed at their GMM estimates. The assets returns used in the unconditional estimates are the 10 CRSP size decile portfolio, one investment excess return, one corporate bond excess return, and the real treasury-bill return. The assets returns used in the conditional estimates, in both unscaled and scaled model, are the deciles 1, 2, 5, 10 returns, and investment and corporate bond excess returns, scaled by instruments, plus the real Treasury-Bill return. Instruments are the constant, term premium, and equally weighted dividend-price ratio. θ_2 is the share of financing cost in investment.

		Pricing Kernel		Jensen's α				Investment Return			
b	θ_2	$\frac{\sigma[M]}{\mathrm{E}[M]}$	ρ_{M,R^S}	α^{vw}	t_α^{vw}	α^{d1}	t_α^{d1}	mean	σ_{R^I}	$\rho(1)$	ρ_{R^I,R^S}
				Unconditional Model							
0.00	0.00	0.76	-0.51	0.54	1.21	1.25	1.59	5.54	3.13	0.00	0.35
0.25	0.04	0.67	-0.20	1.74	3.65	3.37	4.12	5.56	3.35	-0.04	-0.10
0.50	0.09	0.41	-0.03	2.16	4.88	3.98	5.29	5.58	4.85	0.11	-0.29
				Conditional Model							
0.00	0.00	1.07	-0.47	0.25	0.51	0.81	0.95	5.82	2.44	0.06	0.35
0.25	0.05	0.69	-0.24	1.22	2.05	4.15	4.66	5.85	3.01	0.06	-0.19
0.50	0.10	0.72	-0.19	2.12	2.35	5.32	5.74	5.87	4.74	0.18	-0.35
				Scaled Factor Model							
0.00	0.00	1.31	-0.31	0.17	0.33	0.70	0.80	5.89	2.27	0.08	0.35
0.25	0.05	1.04	-0.01	2.15	4.32	4.11	4.84	5.92	2.94	0.09	-0.21
0.50	0.10	0.78	0.10	2.40	5.44	4.37	5.85	5.94	4.73	0.20	-0.36

Table 4 : GMM Estimates and Tests — Alternative Moment Conditions

This table reports results of GMM estimates and tests of the benchmark model with alternative sets of moment conditions. Under alternative one, unconditional model uses the excess returns of CRSP size deciles 1, 2, and 3 portfolios and one investment excess return, and the real Treasury-bill return (5 moment conditions). The conditional estimates, in nonscaled and scaled model, use the deciles 1 and 2 and investment excess returns, scaled by instruments, and the real Treasury-bill return (10 moment conditions). Under alternative two, the unconditional model uses the excess returns of portfolios 11, 13, 15, 21, 23, 25, 41, 43, 45, 51, 53, 55 of the Fama and French (1993) 25 portfolios, one investment excess return, and real Treasury-bill return (14 moment conditions). The FF portfolios are numbered such that the first digit denotes the size group and the second digit denotes the book-to-market group, both of which are in ascending order. For example, portfolio 15 denotes the one formed from the intersection of smallest size and highest book-to-market ratio. The conditional estimates, in nonscaled and scaled model, use excess returns of FF portfolio 11, 15, 33, 51, and 55, scaled by instruments, and the real Treasury-bill return (19 moment conditions). For simplicity, only results for the two factor specification of the pricing kernel are presented.

	Small Deciles						FF Portfolios					
	Unconditional		Conditional		Scaled Factor		Unconditional		Conditional		Scaled Factor	
						Parameters						
a	1.13	(0.12)	8.60	(3.07)	8.16	(2.45)	22.61	(2.34)	18.04	(2.95)	10.37	(4.01)
b	0.00		0.015	(1.24)	0.00		0.00		0.00		0.00	
						Root Mean Squared Pricing Error						
α	0.10		0.69		0.07		0.78		1.08		0.42	
						J_T Test						
χ^2	-		9.66		2.46		43.91		49.80		28.85	
p	-		0.09		0.12		0.00		0.00		0.00	
						Wald Test ($a=0$)						
$\chi^2_{(1)}$	0.77											
p	0.38											
						Wald Test ($b=0$)						
$\chi^2_{(1)}$			0.93									
p			0.33									

Table 5 : GMM Estimates and Tests — Alternative Measures of Profits

This table reports GMM estimates and tests of the benchmark model with a linear G (as in Table 2) using alternative sources of data. Specifically, we consider two alternatives for profit series: nonfinancial profits after tax and aggregate (both financial and nonfinancial) profits. T-statistics are reported in parentheses to the right of parameter estimates. Finally, we also report the root mean square pricing error α — mean return less predicted mean return — in percentage per quarter, where pricing errors are calculated as $\alpha_j = 100 \times \text{E}[MR_j - p_j]/\text{E}[M]$, the χ^2 statistic and corresponding p-value for the J_T test on over-identification, and p-values of Wald test on the null hypothesis that $a = 0$. We conduct GMM estimates and tests for the unconditional model, the unscaled and scaled conditional models, for both one-factor and two-factor specifications of the pricing kernel. The unconditional model uses as moment conditions the excess returns of 10 CRSP size decile portfolio and one investment return, and the real Treasury-bill return (12 moment conditions). The unscaled and scaled conditional model use the deciles 1, 2, 5, 10, and investment returns, scaled by instruments, and the real Treasury-bill return (16 moment conditions). Instruments are the constant, term premium (tp), and equally weighted dividend-price ratio (dp). For brevity, only results for two factor specifications of the pricing kernel are presented.

	Nonfinancial After Tax						Aggregate Profits					
	Unconditional		Conditional		Scaled Factor		Unconditional		Conditional		Scaled Factor	
						Parameters						
a	4.16	(2.32)	4.60	(2.85)	3.67	(3.70)	7.36	(1.12)	13.61	(3.16)	6.35	(1.61)
b	0.00		0.00		0.01	(0.70)	0.00		0.00		0.00	
						Root Mean Square Pricing Error						
α	0.27		0.67		0.26		0.22		0.54		0.29	
						J_T Test						
χ^2	4.67		14.60		10.46		9.56		17.72		9.04	
p	0.70		0.20		0.16		0.21		0.09		0.25	
						Wald Test ($a = 0$)						
$\chi^2_{(1)}$							5.89				11.17	
p							0.02				0.00	
						Wald Test ($b = 0$)						
$\chi^2_{(1)}$					0.35							
p					0.55							

Table 6 : GMM Estimates and Tests — Alternative Specifications

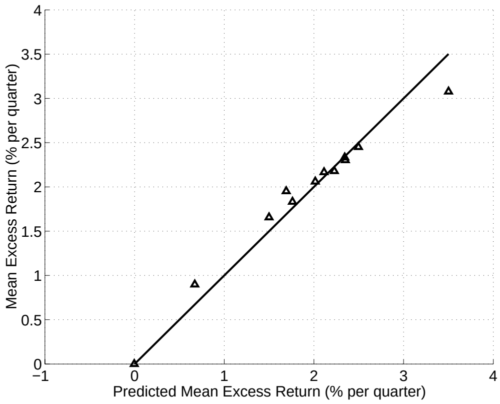
This table reports GMM estimates and tests of two alternative pricing kernels M and one alternative G function. Alternative one of M assumes that $M = l_0 + l_1 R^I + l_2 (R^I)^2$, where R^I is the investment return. Alternative two uses that $M = l_0 + l_1 R^I + l_2 R^B + l_3 (R^I)^2 + l_4 (R^B)^2$, where R^B denotes real corporate bond return. The alternative G is that $G = b_t \left(RB_t + I_t + H_t - \Pi_t \right)^2 / K_t$, where RB_t denotes outstanding debt including interest and $b_t = b \times \mathrm{DF}_t$ with DF_t being the default premium. The investment return series is constructed from flows of funds accounts using nonfinancial profits before tax. The unconditional model uses as moment conditions the excess returns of 10 CRSP size decile portfolio and one investment return and the real Treasury-bill return (12 moment conditions). The unscaled and scaled conditional models use the deciles 1, 2, 5, 10, and investment returns, scaled by instruments, and the real Treasury-bill return (16 moment conditions). Instruments are the constant, term premium (tp), and equally weighted dividend-price ratio (dp).

	$M = l_0 + l_1 R^I + l_2 (R^I)^2$			$M = l_0 + l_1 R^I + l_2 R^B + l_3 (R^I)^2 + l_4 (R^B)^2$			$G = b_t \left(RB_t + I_t + H_t - \Pi_t \right)^2 / K_t$		
	Unconditional	Conditional	Scaled Factor	Unconditional	Conditional	Scaled Factor	Unconditional	Conditional	Scaled Factor
				Parameters					
a	9.35 (4.35)	9.60 (4.87)	9.89 (4.87)	11.02 (2.49)	16.12 (1.88)	17.72 (0.55)	15.13 (1.73)	9.29 (4.28)	8.97 (4.02)
b	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.025 (0.63)	0.04 (0.68)
				Root Mean Squared Pricing Error					
α	0.29	1.01	0.44	0.18	0.45	0.11	0.34	0.70	0.33
				J_T Test					
χ^2	10.99	21.28	10.47	6.42	8.72	4.59	8.24	15.09	7.95
p	0.14	0.09	0.16	0.27	0.46	0.03	0.31	0.18	0.34
				Wald Test ($a = 0$)					
$\chi^2_{(1)}$					52.61	1.37	18.33		
p					0.00	0.24	0.00		
				Wald Test ($b = 0$)					
$\chi^2_{(1)}$								0.70	1.57
p								0.40	0.20

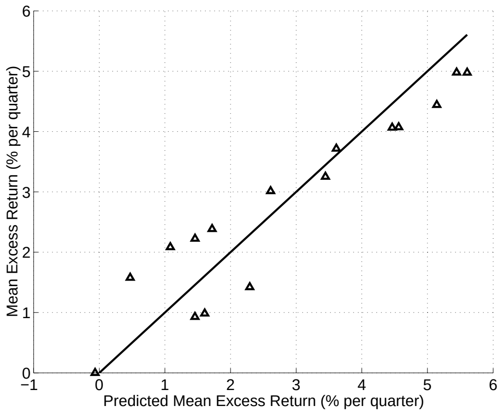
Figure 1 : Predicted Versus Actual Mean Excess Returns

This figure plots the mean excess returns against predicted mean excess return, both of which are in % per quarter, for conditional model (Panel A), conditional model (Panel B), and scaled factor model (Panel C). All plots are from first-stage GMM estimates.

Panel A: Unconditional Estimates



Panel B: Conditional Estimates



Panel C: Scaled Factor

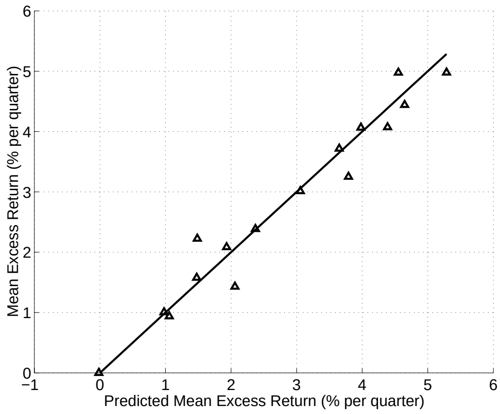


Figure 2 : Correlation Structure

This figure presents the correlations of investment return R^I, real value-weighted market return R^S, the growth rate of default premium DF_{t+1}/DF_t with I/K and Π/K with various leads and lags. Panel A plots the correlation structure of the above series with I/K and Panel B plots that with Π/K.

Panel A: Correlation With I/K

Panel B: Correlation With Π/K