Investment and the Weighted Average Cost of Capital

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Abstract

In a standard q-theory model, corporate investment is negatively related to the cost of capital. Empirically, we find that the weighted average cost of capital matters for corporate investment. The form of the impact depends on how the cost of equity is measured. When the capital asset pricing model is used, firms with a high cost of equity invest more. When the implied cost of capital is used, firms with high cost of equity invest less. The implied cost of capital may better reflect the time-varying required return on capital. The CAPM measure reflects forces that are outside the standard model.

JEL Codes: G31; G32
Keywords: Weighted average cost of capital, investment, CAPM, implied cost of capital

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1. Introduction

How does the cost of capital affect corporate investment? To government policy makers, the answer seems obvious: they keep interest rates low to stimulate corporate investment. This feature is a basic component in many academic papers that focus on other issues. And yet, perhaps surprisingly, the empirical corporate investment literature largely ignores the question of how the cost of capital affects corporate investment.

In this paper, we study how the weighted average cost of capital (WACC) affects corporate investment using U.S. firm-level data from 1955 to 2011. We use the model from the work of Abel and Blanchard (1986) to relate the optimal level of corporate investment to a firm's cash flow and cost of capital. The model predicts that a high cost of capital leads to low investment.We provide strong empirical evidence that the weighted average cost of capital matters for corporate investment. The form of the impact, however, is more complex than predicted by the model.

To understand the complexity of this impact, recall that the weighted average cost of capital consists partly of the cost of debt and partly of the cost of equity. As predicted, firms with a high cost of debt invest less. However, the degree of impact of the cost of equity depends on how it is measured. The cost of equity can be measured by a factor model such as the capital asset pricing model (CAPM). It can also be measured by an implied cost of equity capital (ICC) model. The ICC-based results match the model predictions, but the CAPM-based results do not.

When the CAPM, or a related factor model,[1] is used to infer the cost of equity, the

[1] We examine the factors of Fama and French (1993), Carhart (1997), Kogan and Papanikolaou (2013),

WACC is significantly positively related to corporate investment. This finding arises from the fact that the usual factor models produce costs of equity that are positively related to corporate investment. This positive relation overwhelms the impact of the cost of debt.

When an ICC model is used to infer the cost of equity, the weighted average cost of capital is significantly negatively related to corporate investment.[2] We find that the ICC models produce costs of equity that are negatively related to corporate investment. This negative relation complements the impact of the cost of debt.

How should these findings be interpreted? The ICC-based results are readily interpreted by the model. Pastor, Sinha, and Swaminathan (2008) provide a set of conditions under which the ICC is a perfect proxy for time-varying expected equity returns. Accordingly, Abel and Blanchard (1986) and Pastor, Sinha, and Swaminathan (2008) together provide a good theoretical foundation for the observed impact of ICC on corporate investment. The conclusion is that the cost of capital negatively affects investment and is an important force in firms' capital budgeting decisions.

Interpreting the CAPM-based result is not as straightforward. Naturally, the literature is rather critical of the CAPM. A logical conjecture, then, is that the CAPM simply provides a noisier proxy for the expected cost of equity than the ICC provides. To test this idea, we estimate investment regressions with both ICC- and CAPM-based estimates included. If the CAPM measure were simply a poor proxy, the coefficient on this variable might not be statistically significant. Empirically, however, both are statistically significant, and both have their original signs. Thus, the CAPM-based estimate provides empirically relevant

and Novy-Marx (2013).

[2]We examine a number of closely related methods drawing on work by Gebhardt, Lee, and Swaminathan (2001), Pastor, Sinha, and Swaminathan (2008), Chava and Purnanandam (2010), Hou, van Dijk, and Zhang (2012), Li, Ng, and Swaminathan (2013) and Tang, Wu, and Zhang (2014).

information for investment that is distinct from that provided by the ICC. However, the impact of the CAPM-based cost of equity on investment is not the cost of capital effect predicted by Abel and Blanchard (1986). Some other mechanism must be at work. We provide suggestive evidence on a number of possibilities that draw on the literature.

To the best of our knowledge, this paper is the first to systematically study the impact of the WACC and its components on firm-level investment. Surprisingly few studies have been done of the WACC in general. Kaplan and Ruback (1995) study a sample of high leverage transactions between 1983 and 1989, and Gilson, Hotchkiss, and Ruback (2000) study a sample of firms in bankruptcy reorganization. In both papers, the discounted cash flow analysis performs well. These studies do not focus on the components of the WACC, and they leave unclear how broadly applicable the approach might be.

A number of papers focus on the impact of investment on stock returns, such as Zhang (2005), Carlson, Fisher, and Giammarino (2004), Carlson, Fisher, and Giammarino (2006), Liu, Whited, and Zhang (2009), and Lin and Zhang (2013). Their models are generally similar to the one in Abel and Blanchard (1986) and are used to explain future stock return spreads across portfolios sorted by firm characteristics. In contrast to the investment-based asset pricing literature, this paper focuses on the impact of the cost of capital on corporate investment.

The classic implied cost of equity capital approach uses the Gordon growth model. An increasingly popular version is based on residual income accounting as proposed by Gebhardt, Lee, and Swaminathan (2001) and further studied by Pastor, Sinha, and Swaminathan (2008), Hou, van Dijk, and Zhang (2012), Lewellen (2010), and Chava and Purnanandam (2010), among others. Our paper uses both the Gordon growth model and the residual income model. They produce similar results.

Although much of the corporate investment literature has focused on q-theory, this paper is not the first to adopt the method in the work of Abel and Blanchard (1986). Their original paper examines aggregated data and does not obtain clear evidence of the role of the WACC. Using a similar approach, Gilchrist and Himmelberg (1995) attempt to use the model to construct a better measure of Tobin's q and to understand differences among firms with respect to the impact of cash flows. These studies do not use the model to examine the differing impacts of the cost of debt and the cost of equity on investment.

Philippon (2009), Gilchrist and Zakrajsek (2007), and Gilchrist and Zakrajšek (2012) study whether the cost of debt affects investment at the aggregate and firm levels. Our evidence on the impact of the cost of debt is similar to theirs, but neither of these papers examines the impact of the cost of equity on investment. Also noteworthy is that it appears challenging to identify the impact of the cost of debt on investment in the aggregate data, as reported by Kothari, Lewellen, and Warner (2014).

Section 2 derives the model of corporate investment. The data and descriptive statistics are discussed in Section 3. Investment regression results based on the measures from the CAPM and related models are reported in Section 4. Implied cost of equity capital results are reported in Section 5. The conclusion is in Section 6.

2. Corporate Investment Model

In this section, we first derive a directly testable investment equation based on the model in the work of Abel and Blanchard (1986). The optimal corporate investment is related to a firm's cash flow and cost of capital. This relationship relies on assumptions about the cost of capital dynamics. Accordingly, we also discuss how relaxing these assumptions affects the key predictions.

2.1. The Basic Model

The model follows that in the work of Abel and Blanchard (1986). To explain the model, we define the following variables: $V(\cdot,\cdot)$ is the value of the firm, K_t is the capital stock, I_t is the investment, δ is the rate at which capital depreciates ($0 < \delta < 1$), r_t is the discount rate (or, as observed by Abel and Blanchard (1986), the WACC), $\pi(\cdot,\cdot)$ is the flow of revenue in a period, $c(\cdot,\cdot)$ is the capital adjustment cost, ϕ is an adjustment cost parameter ($\phi > 0$), a_t is the profit shock, and Ω_t is the information set available to firm at period t. The firm subscript i is suppressed where it is obvious.

The adjustment cost function is linear homogeneous in I_t and K_t, and it is given by $c(I_t, K_t) = I_t + \frac{\phi}{2}(\frac{I_t}{K_t})^2 K_t$. The capital accumulation process is $K_{t+1} = K_t(1-\delta) + I_t$. The firm chooses investment to maximize the expected present value of the firm:

$$V(a_t, K_t) = E\left\{\sum_{j=0}^{\infty} \frac{\pi(a_{t+j}, K_{t+j}) - c(I_{t+j}, K_{t+j})}{\Pi_{s=1}^{j}(1 + r_{t+s})} |\Omega_t\right\} \tag{1}$$

The first order condition with respect to investment and the quadratic adjustment cost function together imply that optimal investment can be written as

$$\frac{I_t}{K_t} = -\frac{1}{\phi} + \frac{1}{\phi} q_t \; , \tag{2}$$

where

$$q_t = E\left\{\sum_{j=1}^{\infty} \frac{(1-\delta)^{j-1}[\pi_K(a_{t+j}, K_{t+j}) - c_K(I_{t+j}, K_{t+j})]}{\Pi_{s=1}^{j}(1+r_{t+s})}|\Omega_t\right\}. \tag{3}$$

As usual, q is the expected sum of all discounted future marginal benefits of one additional unit of capital. If q is directly observable, then there is no need to go further. However, it is well known that the usual measures of q are not entirely satisfactory. This finding motivates Abel and Blanchard (1986) to use a vector autoregression to decompose q into the more basic driving forces.

To show how this decomposition works, let the one-period discount factor be $\beta_{t+s} = (1-\delta)/(1+r_{t+s})$, and let the one-period marginal product of capital be $M_{t+j} = [\pi_K(a_{t+j}, K_{t+j}) - c_K(I_{t+j}, K_{t+j})]/(1-\delta)$. Then q can be rewritten as

$$q_t = E\left\{\sum_{j=1}^{\infty} \left[\Pi_{s=1}^{j}\beta_{t+s}\right] M_{t+j}|\Omega_t\right\}. \tag{4}$$

Take a first order Taylor expansion for the term inside the expectation around the mean of β_t and M_t. As in equation 7 from Abel and Blanchard (1986),

$$q_t = E\left\{\frac{\overline{M}\overline{\beta}}{(1-\overline{\beta})} + \sum_{j=1}^{\infty}\overline{\beta}^j(M_{t+j} - \overline{M}) + \frac{\overline{M}}{(1-\overline{\beta})\overline{\beta}}\sum_{j=1}^{\infty}\overline{\beta}^j(\beta_{t+j} - \overline{\beta})|\Omega_t\right\}. \tag{5}$$

Equation 5 decomposes q into: 1) a constant term, 2) a discounted sum of the deviations of the marginal product of capital from the average value, and 3) a discounted sum of the deviation of the discount factors from the average values.

To make use of equation 5 in empirical work, it is necessary to specify the dynamics of

β and M. Consider an AR(1) model,

$$\beta_{t+1} = \overline{\beta} + \rho_\beta(\beta_t - \overline{\beta}) + \sigma_\beta \varepsilon_{\beta,t+1} \tag{6}$$

$$M_{t+1} = \overline{M} + \rho_M(M_t - \overline{M}) + \sigma_M \varepsilon_{M,t+1}\ , \tag{7}$$

where $\varepsilon_{M,t} \sim N(0,1)$, $\varepsilon_{\beta,t} \sim N(0,1)$, and $\rho_\beta, \rho_M, \sigma_\beta, \sigma_M$ are constants that are known to the firm. This assumption is used to evaluate the three terms on the right-hand side of equation 5. The first term is just an expectation of a constant. The second term is given by

$$E\left[\sum_{j=1}^{\infty} \overline{\beta}^j (M_{t+j} - \overline{M})|\Omega_t\right] = \sum_{j=1}^{\infty} \overline{\beta}^j \rho_M^j (M_t - \overline{M}) = \frac{\overline{\beta}\rho_M(M_t - \overline{M})}{(1 - \overline{\beta}\rho_M)}. \tag{8}$$

The third term is given by

$$E\left[\overline{M}(1-\overline{\beta})^{-1}\overline{\beta}^{-1} \sum_{j=1}^{\infty} \overline{\beta}^j (\beta_{t+j} - \overline{\beta})|\Omega_t\right] = \frac{\overline{M}}{(1-\overline{\beta})\overline{\beta}} \sum_{j=1}^{\infty} \overline{\beta}^j \rho_\beta^j (\beta_t - \overline{\beta}) = \frac{\overline{M}\rho_\beta(\beta_t - \overline{\beta})}{(1-\overline{\beta})(1-\overline{\beta}\rho_\beta)}. \tag{9}$$

Substituting these terms back into equation 5 gives

$$q_t = \frac{\overline{M\beta}}{(1-\overline{\beta})} + \frac{\overline{\beta}\rho_M(M_t - \overline{M})}{(1-\overline{\beta}\rho_M)} + \frac{\overline{M}\rho_\beta(\beta_t - \overline{\beta})}{(1-\overline{\beta})(1-\overline{\beta}\rho_\beta)}. \tag{10}$$

Proxies for both M and β are needed. Because $\beta_t = (1-\delta)/(1+r_t)$, it follows that $\beta_t \approx 1 - r_t - \delta$. Following the work of Abel and Blanchard (1986), we assume that observable average profit equals unobservable marginal profit and, hence, $[\pi(a_t, K_t) - c(I_t, K_t)]/K_t = \pi_K(a_t, K_t) - c_K(I_t, K_t)$. It is common to use the ratio of cash flow to capital stock $CashFlow_t/K_t$ as a proxy for average profit.

After simple algebra, the investment regression becomes

$$\frac{I_t}{K_t} = \alpha_0 + \alpha_1 \frac{CashFlow_t}{K_t} + \alpha_2 WACC_t. \tag{11}$$

According to the model, the coefficients are given by $\alpha_0 = -\frac{1}{\phi} + \frac{\overline{M\beta}}{\phi(1-\overline{\beta})} - \alpha_1 \overline{M} - \alpha_2 \overline{WACC}$ with $\overline{WACC} = 1 - \delta - \overline{\beta}$, $\alpha_1 = \frac{\overline{\beta}\rho_M}{\phi(1-\delta)(1-\overline{\beta}\rho_M)} > 0$ and $\alpha_2 = -\frac{\overline{M}\rho_\beta}{\phi(1-\overline{\beta})(1-\overline{\beta}\rho_\beta)} < 0$.

The intercept α_0 is fairly complex. It reflects the adjustment cost technology (ϕ), the long-run marginal q (i.e. $\overline{M\beta}/(\phi - \phi\overline{\beta})$), and the product of the per unit impact of all future changes in cash flow (α_1) or WACC (α_2) and the number of units in long-run ($\overline{M}$ and $\overline{WACC}$).

The impact of cash flow is given by α_1. It reflects the adjustment cost technology (ϕ), whereas $(\overline{\beta}\rho_M)/(1 - \overline{\beta}\rho_M)$ is a combination of both the time discount parameter $\overline{\beta}$ and the marginal profit shock persistence parameter ρ_M. In effect it subsumes the impact of all future marginal profit shocks on optimal investment.

We take a first order approximation to get the impact of WACC. As a result, the changes in β_t are an affine function of the changes in WACC with the opposite sign. This implies that α_2 should have a negative sign. In α_2, the term $(\rho_\beta)/(\phi(1 - \overline{\beta})(1 - \overline{\beta}\rho_\beta))$ can be viewed as a proportional factor. The product of this proportional factor and $\overline{M}$ transforms the future expected changes in WACC. These results are brought into terms of marginal profit that determine current optimal investment. Because the assumption is that the long-run mean of WACC and cash flow are constant, the variation in WACC and cash flow are equivalent to the deviations from their respective long-run means.

2.2. Is the AR(1) Assumption Misleading?

In the derivation of equation 11, the AR(1) assumption provides considerable simplification. Here we examine whether this assumption is a reasonable approximation for the model. Then we discuss how a more general dynamic structure could affect the key predictions. The assumption that conditional expected returns follow an AR(1) process is reasonably common, as shown in the work of in Campbell and Shiller (1988) and Pastor, Sinha, and Swaminathan (2008).

Consider the dynamics of each cost component of WACC using firm-level data. Let $(1 - r_t - \delta)$ replace β_t so that $r_{t+1} = \overline{r}(1 - \rho_\beta) + \rho_\beta r_t + \sigma_\beta \varepsilon_{\beta,t+1}$. WACC is used as a proxy for r_t. The stock returns component of WACC is a sum of the risk-free rate and an excess return. The risk-free rate is highly serially correlated. Using a one-month Treasury bill rate, the ρ_β is about 0.968 with an R^2 above 90% over the period 1950-2011. So the risk-free rate level component is quite predictable. The excess returns are much less predictable. However, in the same time period, ρ_β is about 0.088 and significant at a 5% level under Newey-West standard errors. If the beta of firm debt is near zero, then the cost of debt is close to the risk-free rate and likewise ought to be predictable. Thus, each cost component of the WACC indeed has features that are consistent with an AR(1) process.

Another concern is that different results might emerge if more conditioning factors are reflected in the dynamic structure. To address this concern, we relax the AR(1) assumption by studying vector autoregressions (VAR) as in the work of Abel and Blanchard (1986) and then studying a more general factor-augmented vector autoregression (FAVAR) model using the methods of Ludvigson and Ng (2009). Both structures are more flexible, but they require a balanced panel for a long time series. We perform the test using aggregated firm-level variables and find essentially similar results for how the cost of capital affects investment. So the AR(1) process is sufficient to capture the main force at work. Allowing more general dynamic structures does not alter the key predictions.

2.3. Is Risk Neutrality Too Strong an Assumption?

The Abel and Blanchard (1986) model assumes that the decision maker is risk neutral. This assumption is common in macroeconomics and corporate finance, because the impact of risk is often thought to be a concern that is secondary to other aspects of the problem. In the asset pricing literature, tracing out the impact of risk on returns is often the key issue. Therefore, it is natural to wonder whether the assumption of risk neutrality is problematic for our purposes as well. An additional reason for concern about risk neutrality is the impact on the interest rate a firm must pay. Assuming that the beta of firm debt is zero should imply that the cost of debt is close to the risk-free rate. In reality, it is often far from the risk-free rate proxy.

To deal with this concern, we examine models used in the literature that studies the impact of investment on stock returns. These models typically have a structure similar to that in the work of Abel and Blanchard (1986). The major difference is that they use a stochastic discount factor instead of assuming risk neutrality. It turns out that allowing for risk aversion does not alter the aspects of the models that we are interested in. For example, the models in Liu, Whited, and Zhang (2009) and Lin and Zhang (2013) make similar predictions about α_2 in equation 11.

To see this, consider the two-period model from Lin and Zhang (2013). Let r^{Ba}_{it+1} be the after-tax corporate bond return for firm i on date $t+1$, r^{S}_{it+1} the return on equity, w_{it} the market leverage, $a > 0$ the adjustment cost parameter, I_{it} investment, K_{it} the firm's capital stock, and Π_{it+1} the marginal benefit of extra unit of capital over period t+1.

Lin and Zhang (2013) show that

$$1 + a(\frac{I_{it}}{K_{it}}) = \frac{\Pi_{it+1}}{w_{it}r^{Ba}_{it+1} + (1-w_{it})r^{S}_{it+1}}. \tag{12}$$

This equation says that the marginal cost of installing an extra unit of capital over period t should be equal to the present value of the marginal benefit brought by this extra unit of capital over period $t+1$. The discount factor is $w_{it}r^{Ba}_{it+1} + (1-w_{it})r^{S}_{it+1}$, which is WACC. Because $a > 0$, $1 > w_{it} > 0$, and $\Pi_{it+1} > 0$, a high cost of equity is associated with a low investment-capital ratio ceteris paribus. The impact of the cost of equity and debt have the same sign as in the work of Abel and Blanchard (1986). Thus, allowing for risk aversion does not appear to alter the key theoretical predictions that we focus on.

3. Data and Descriptive Statistics

The firm-level data are from Compustat and the Center for Research in Security Prices (CRSP). Firms in utilities and the financial industry are omitted. Variables are winsorized at a 1% level in each tail.

To give the standard definition of WACC, let E denote the value of equity, D the value of debt, $V = D + E$ the total value of the firm, r_E the equity cost of capital, r_D the debt cost of capital, τ_c the corporate tax rate, and r_{wacc} the weighted average cost of capital:

$$r_{wacc} = \frac{E}{V} r_E + \frac{D}{V} r_D (1 - \tau_c) \tag{13}$$

Computation of r_{wacc} thus requires measuring r_E, r_D, E, D, V, and τ_c. For each of these, many plausible alternative proxies are available. Although some choices are more common than others, a remarkably large number of alternative proxies can be used to measure the WACC.[3] We report empirical results for a few versions that provide a good reflection of the results from the larger population of proxies. For each component of the WACC, the variable construction details are provided in the Appendix.

Table 1 provides descriptive statistics. The sample includes 9,714 firms from 1955 to 2011. The average firm appears in the data for 24.25 years. The average number of observations in each regression is about 85,000. Firms have an average investment-capital ratio of 0.306, but the median is just 0.206.

The ratio of cash flow to capital is commonly included in investment regressions. In the model, it enters as a component of the q decomposition. Following the work of Fazzari, Hubbard, and Petersen (1988), a large literature includes the cash flow in regressions and interprets it as a measure of market imperfection. Many other studies, however, follow Erickson and Whited (2000), who direct attention to measurement error in q as being at least partly responsible for its significant effect. Thus, the interpretation of this variable has been controversial. Empirically, firms have dramatic cross-sectional differences among them, so the 25th percentile value is about one-quarter of the value at the 75th percentile.

[3] In an earlier draft of this paper, results for 440 different versions are provided.

In the main analysis, we drop the firms with a negative average cash flow for two reasons. First, in the model long-run marginal q is $(\overline{M\beta})/(\phi(1-\overline{\beta}))$, which should be positive. Therefore $\overline{M}$, which is the average profit, must be positive. Second, the predicted sign of the coefficient on WACC is $\alpha_2 = -\frac{\overline{M}\rho_\beta}{\phi(1-\overline{\beta})(1-\overline{\beta}\rho_\beta)}$. If the data contain a mix of firms with $\overline{M} > 0$ and $\overline{M} < 0$, the empirical prediction is less clear-cut. However, this empirical restriction is fairly innocuous. The main findings are robust when we include firms with negative average cash flow. These results are not of independent interest and so are not tabulated.

Throughout this paper, except where something else is specifically mentioned, daily stock return data in a calendar year are used to calculate the cost of equity. We do not use a rolling window regression of monthly data as the main case. The reason is a concern about potentially spurious autocorrelation in the cost of equity if overlapping data are used. As a robustness check, we verify that rolling window methods lead to the same qualitative inferences.

The average cost of equity over all firms and all years is about 0.2. However, variation can be found across methods of calculation and across firms. The average cost of equity based on the CAPM is about 0.166. Using the Fama-French 3-factor model, the average is about 0.228. The measure based on the Carhart model is similar in magnitude to the Fama-French version. In all three approaches, the cross-sectional differences are considerable. For example, at the 25th percentile, the CAPM version of the cost of equity is 0.096, whereas at the 75th percentile it is 0.221. For the other measures, the cost of equity at the 25th percentile is also about half of the value at the 75th percentile. These three measures of the cost of equity are highly correlated, as shown in Table 8.

A variety of methods can be used to compute the cost of debt. We use the firm's actual average cost of debt as the main case. This method is particularly simple to compute and interpret. However, the method may not correctly reflect the current debt market conditions faced by the firm. The cost of debt computed this way may appear to be much smoother than the actual debt market rates.[4]

The mean corporate cost of debt is about half of the cost of equity. The cost of debt also has a huge spread so that the 25th percentile value of 0.027 is less than half of the 75th percentile value of 0.078. These differences partly reflect time series variation, but they also reflect differences among firms at a moment in time arising from creditworthiness and other factors.

The average income tax rate paid by a firm is used as a proxy for the firm's marginal tax. The average tax rate according to this proxy is about 0.355. This proxy may be a good measure if the firm's tax rate is very persistent from year to year. It also has the merit of simplicity and easy availability. With this measure, a long-term decline in the corporate tax occurs between 1955 and 1990. After 1990 the corporate tax is fairly flat. This basic pattern is also found for other tax proxies.[5]

We use the firm's own current market leverage as the main measure of leverage. Two

[4]To see whether greater attention to current market rates would matter, we try several alternatives. First, we infer the cost of debt using the firm's credit rating and Ibbotson's data. The cost of debt is the bond return for firms with a given credit rating in a particular year. Second, we use the average yield of the firm's incremental debt issued during the year as a proxy. This method should more closely reflect current market conditions in the given year. Because of data requirements, however, this method reduces the sample size. The inferences to be drawn are not affected by these alternatives. Therefore, we focus on the firm's own average cost of debt.

[5]An alternative tax proxy is to use the tax code directly. The top statutory federal corporate income tax rate has the advantage that it is actually exogenous to a given firm. However, the tax code is complex, and not all firms are paying the top marginal rate. This alternative is tried, and it does not change the qualitative inferences. More sophisticated tax measures are provided by Graham and Mills (2008), who include more tax code structure. We examine two measures from their paper. The first is a simulated tax, which covers the period from 1980 to 2010. This measure does not cover all the firms. The second measure is an OLS predicted tax, which covers a large portion of the sample. The tax effects are fairly small empirically, and the main results on the cost of debt and equity do not hinge on the choice of tax proxy.

alternatives are also studied: the impact of using target leverage generated by the empirical model from the work of Frank and Goyal (2009) and an equally weighted sum of market leverage and industry median leverage. These alternatives do not alter the qualitative results, and so the results are not tabulated.

The overall weighted average cost of capital depends on both the cost of debt and the cost of equity. Because of the cost of equity, the CAPM version of WACC is lower than the others. In general, the 75th percentile value is more than double the value of the 25th percentile.

The descriptive statistics show that there is a considerable variation in the cost of capital and that there is a real difference between the average cost of debt and the average cost of equity. Going beyond the table there is, of course, significant cross-sectional variation within each year.

4. Investment Regressions

This section provides investment regression results in which the cost of equity is based on the CAPM or a related factor model. We first report results for the WACC itself and then report the results from decomposition regressions. In these regressions, the components of WACC are included as separate explanatory variables. Then we perform a number of robustness tests and examine some alternative ideas.

4.1. Basic Estimates

According to equation 11, corporate investment is a function of cash flow and WACC. This is our basic regression specification. We include firm and year fixed effects to mitigate the impact of potentially omitted variables. The standard errors are clustered both by firm and by year.

Table 2 reports the results. In columns 1 to 3 both cash flow and WACC are contemporaneous, and in columns 4 to 6 they are both lagged by one year. The cost of capital is computed using the CAPM (columns 1 and 4), the Fama-French 3-factor model (columns 2 and 5), and the Carhart model (columns 3 and 6).

In all cases, cash flow has a positive and significant impact on investment. According to the model, the impact of cash flow on investment is expected because it is a component of marginal q. Previous literature also finds a similar impact of cash flow on investment, but the interpretation is controversial. In a standard investment regression, the inclusion of the proxy for marginal q does not subsume the effect of cash flow. This result can be interpreted as evidence of financial constraints, as in the work of Fazzari, Hubbard, and Petersen (1988), or as evidence of measurement error in the proxy for marginal q, as in the work of Erickson and Whited (2000).

Some ambiguity is associated with the relative merits of using lagged or contemporaneous variables. According to the model, the contemporaneous variables should be used because they better capture the dynamics of marginal q, which is a forward-looking measure. Empirically, lagged explanatory variables are often used because they represent the information that is clearly available to firms when decisions are being made. In our empirical tests, the coefficients on cash flow are generally larger in contemporaneous specifications.

In the sample used in Table 2, the mean investment-capital ratio is 0.276. A one standard deviation increase in the CAPM version of WACC is associated with an increase of 0.029 (or 10.5%) in the investment-capital ratio. This is a sizeable economic effect given the inclusion of firm and time fixed effects. These effects already explain a lot of the variation in firm investment. For the Fama-French and Carhart versions, a one standard deviation increase in the WACC is associated with a 5% increase in the investment-capital ratio. These empirical differences reflect the fact that the Fama-French and Carhart versions of the cost of equity have weaker effects on corporate investment than does the CAPM version. Similar results are observed in the decomposition analysis.

The results in Table 2 clearly show that WACC has a positive and significant impact on investment. If WACC is interpreted strictly as a cost of investment, this result is surprising. An increase in cost should be associated with a reduction in the volume of purchases, other things being equal. Of course, alternative mechanisms could be at work here. The next step is to clarify the empirical basis for the observed positive sign. Because WACC is an aggregate of several data items, unbundling the components is of interest.

4.2. Decomposing WACC

To help interpret the sign on the WACC, we check whether the cost of debt and the cost of equity affect investment in the same manner. Table 3 provides estimates from investment regressions in which the components of WACC are used instead of the WACC itself. This table reports results from contemporaneous regressions, but the lagged versions give similar qualitative results.

Column 1 decomposes the CAPM version of WACC into a debt group of terms, $\frac{D}{V}r_D(1-\tau_c)$, and an equity group of terms, $(1-\frac{D}{V})r_E$. The coefficient on the cost of equity group is positive and matches the result for WACC given in Table 2. The coefficient on the cost of debt group of terms is negative. Both coefficients are statistically significant. Because of the presence of both $\frac{D}{V}$ and $(1-\frac{D}{V})$ in the corresponding calculation, a multi-collinearity issue might be of concern. To alleviate this concern, we compute the correlation between the debt group of terms and the equity group of terms and find that the correlation is -0.28. The sign is consistent with the regression results, but these two variables are not strongly correlated.

The coefficient on the debt group of terms is much larger than the coefficient on the equity group of terms. This disparity arises from the different averages of the groups. The average debt group of terms is 0.008, whereas the average equity group of terms is 0.134, which is more than 15 times as large. Market leverage drives this sharp difference. In our sample, about 15% of the firm-year observations have a realized market leverage of 0.05 or less. These extreme values affect the coefficient on the debt group of terms.[6] A 10% increase in the debt group of terms will lead to a 1.4% decrease in the investment-capital ratio, whereas a 10% increase in equity group of terms will lead to a 1.7% increase in the investment-capital ratio. Although their coefficients are different, their economic magnitudes are similar.

In column 2 of Table 3, the market-to-book ratio is included as an additional explanatory

[6]We also use the target leverage generated by the work of Frank and Goyal (2009) when computing the WACC. Because the average target leverage is about 0.2 in the sample of almost zero leverage firms (market leverage is less than 0.05), it generates a more comparable size of coefficients on the debt and equity group of terms than the market leverage generates.

variable. Although it is statistically significant, the key point is that it does not alter the sign or significance of the impact of either the debt or equity group on investment. Column 3 further decomposes the cost of debt and cost of equity groups of terms. Each term now enters the regression linearly rather than multiplicatively. The R^2 is slightly lower for the linear specification. In column 3, we again see that the cost of debt has a negative impact on investment and the CAPM version of cost of equity has a positive coefficient. Without interacting with market leverage, the coefficient of the cost of debt becomes more comparable to the cost of equity. A one standard deviation increase in the cost of debt is associated with a 4.9% decrease in the investment-capital ratio, whereas a one standard deviation increase in the cost of equity is associated with a 5.6% increase in the investment-capital ratio.

In columns 4 to 6, the Carhart versions give qualitatively similar results to those in columns 1 to 3, but the economic impact of the cost of equity is smaller. The CAPM version of the cost of equity has a larger impact on corporate investment than either the Fama-French or Carhart versions. Theoretically, it is unclear which version of the cost of equity should have a larger impact. Empirically, the additional asset pricing factors in the Fama-French or Carhart model seem to weaken the relation between corporate investment and the cost of equity to a minor extent. However, this difference in magnitudes is a second order issue relative to the fact that the coefficient has a positive sign.

The decompositions in Table 3 show that the signs on the WACC observed in Table 2 are driven to a large extent by the impact of the cost of equity and are not due to the cost of debt. It also shows that the result is not just a reflection of the CAPM itself. When other asset pricing factors are included to get the Carhart version of the cost of equity, the overall results are similar.

4.3. Are Findings Driven by Time Period?

Sometimes surprising results can be driven by a particular sample period. For example, Chen and Chen (2012) show that in an investment regression, cash flow is less important than Tobin's q in recent decades. This finding raises the question: to what extent might our findings be driven by a narrow time period?

To answer this question, Table 4 provides results by decade from 1970 to 2011 for investment regressions using the CAPM version of WACC. Similar results are found in each decade. The coefficient on WACC is consistently positive and statistically significant. In each decade, the cost of debt has a negative coefficient. In each decade, the CAPM version of the cost of equity has a positive coefficient.

Consistent with the work of Chen and Chen (2012), the magnitude of the cash flow term declines between the 1970s and the 2000s. However, the sign and the significance of cash flow remain intact. The impact of the cost of debt also declines in the 2000s when compared with earlier decades. The impact of the cost of equity in the 1970s is weaker than that in subsequent decades. Table 4 confirms that the results in Table 2 are not unique to a particular decade.

4.4. How Important Are Differences among Firms?

Firms have many differences among them, and some differences might alter our understanding. We focus on differences in leverage and firm size as being of particular potential interest.

Leverage differences among firms might be quite important because some firms have almost no debt. These firms might not be very sensitive to the cost of debt. Strebulaev and Yang (2013) define firms with a leverage ratio of 0.05 or less as being "almost zero leverage firms." In Table 5, the first column provides estimates for the almost zero leverage firms and the second column provides estimates for the other firms using the CAPM version of the cost of equity.

Cash flow has an essentially identical impact on the almost zero leverage firms as well as on the other firms. The cost of capital matters for both categories of firms, and it has a much stronger effect for the firms that have almost zero leverage. The coefficients on both the cost of debt and the cost of equity are numerically larger for the almost zero leverage firms.

The fact that the coefficient on the cost of debt is larger for the almost zero leverage firms seems odd at first glance. However, it reflects the fact that the debt group of terms and the investment-capital ratios are different between the almost zero leverage firms and the other firms. For the almost zero leverage firms, the mean of the debt group of terms is 0.0015, and the mean of the investment-capital ratio is 0.424. For the other firms, the mean of the debt group of terms is 0.0096, and the mean of the investment-capital ratio is 0.267. The almost zero leverage firms have a lower debt group of terms and a higher investment-capital ratio. According to the estimates, a one standard deviation shock to the debt group of terms is associated with a 10% change in the investment-capital ratio for the almost zero leverage firms and a 23% change in the investment-capital ratio for the other firms. The implied magnitudes are consistent with the intuition that the cost of debt matters more for high leverage firms.

The observation is made that large and small firms make different choices about corporate policy. A common interpretation is that small firms have limited capital market access and severe asymmetric information problems. To see whether this difference affects our results, we sort firms into size quintiles. In Table 5, the results are reported for the smallest quintile of firms in column 3 and the largest quintile of firms in column 4. The cost of capital has a stronger overall effect on large firms. However, the cost of debt has a more significant effect on small firms.

To summarize, the basic impact of the cost of debt and the cost of equity is found for both low leverage and high leverage firms and for both large and small firms. The coefficient differences are a matter of degree rather than a matter of kind. Neither leverage nor firm size issues fundamentally alter our findings.

4.5. Alternative Measures and Estimation Methods

The academic literature has not reached a consensus on how best to construct an empirical proxy for the cost of capital. Even for the CAPM, many implementations are possible. Theory does not restrict the choice of data frequency to monthly, daily, or some other frequency. Similarly, theory does not fully pin down the length of the estimation period, the risk-free rate choice, or the excess market return measure. Going beyond the CAPM, many new pricing factors have been proposed. The impact of some alternative choices is worth examining. In this section, we focus on the factor models for the cost of equity measures. In the next section, results for the implied cost of capital are presented. These sections are presented separately because of their sharply differing results.

We consider an alternative measure of the cost of debt. In Table 6, column 1 provides the results of an alternative approach to inferring the cost of debt. As a measure of the cost of debt, we follow the work of Liu, Whited, and Zhang (2009) and use corporate bond returns for different rating classes of bonds from Ibbotson Associates.

Using this alternative measure of the cost of debt produces summary statistics that are similar to our main measure. However, the debt group of terms has a smaller coefficient. The smaller coefficient may reflect the fact that bond returns for different rating classes are noisy proxies for the individual firm cost of debt. The Ibbotson Associates data provide bond returns for five bond ratings, so the cost of debt of all firms in each year will have at most five different values. Using imputations from the Ibbotson data is probably more useful for portfolio-level analysis. For individual firms, the coarseness of the measure may bias the coefficient toward zero. In any case, the coefficient on the cost of debt in column 1 remains negative and statistically significant, and so its impact on investment is robust.

Because theory does not restrict some aspects of the data treatment, alternative methods are possible. We consider alternatives for data frequency and the length of the estimation period. The main analysis uses non-overlapping data to estimate the cost of equity in order to avoid spurious autocorrelation. As a robustness check, we estimate the cost of equity for each firm with rolling window regressions using the past 5 years of monthly data. We restrict the analysis to firms for which at least 24 months of non-missing data are available. In column 1 of Table 6 we use the CAPM, and the results are similar to the earlier results. Whether we use the Fama-French model, the Carhart model, or 3 years instead of 5 years of monthly data, all generate results that are similar to what was found earlier.

Harvey, Liu, and Zhu (2013) observe that much of the empirical asset pricing literature involves the identification of factors that might fruitfully extend the CAPM. These factors might have a significant impact on our results. Therefore, we study the impact of several of them and report the results in columns 2 and 3. They provide a good sense of the results generally obtained by adding factors from the literature.

Kogan and Papanikolaou (2013) suggest that investment specific technology (IST) shocks are important. Novy-Marx (2013) suggests that the profitable-minus-unprofitable (PMU) factor is important. Both of these factors are well motivated, and the results from using them are shown in columns 2 and 3 of Table 6, which can be compared with the results in Table 2. The coefficients and even the adjusted R^2 values are similar to those found in Table 2. Adding these factors makes little difference for the inferences.

The potential importance of measurement error is well recognized in the corporate investment literature. Probably the best currently available method of dealing with this problem is provided by Erickson, Jiang, and Whited (2014), who recommend the use of a high-order cumulant estimator. Columns 4 to 6 follow this approach under the assumption that the cost of equity is the mismeasured regressor.

In all three columns, the coefficient on the cost of equity is larger when mismeasurement is taken into account. The estimated impact of the cost of debt is similar to the impact estimated previously, with the exception of column 4. The column 4 coefficient seems to reflect the impact of the almost zero leverage firms. To address this concern, we repeat the exercise, but now we use the target leverage based on the model from the work of Frank and Goyal (2009). This estimated target leverage has a standard deviation about half as big as the market leverage standard deviation. The negative coefficient on the cost of debt reemerges as negative and statistically significant, which is consistent with the idea that the almost zero leverage firms could be the reason for the positive coefficient on debt in column

4.

When measurement error is taken into account, the impact of the CAPM version of the cost of equity on investment is stronger than that in the Fama-French or Carhart versions. This is also the result when simpler estimation methods are used. Recall that ρ^2 is an estimate of R^2 in the regression. As shown in column 4, it is higher for the CAPM than for the Fama-French and Carhart models in columns 5 and 6. To measure estimate quality, consider the value of τ^2. Once again, it is higher for the CAPM than for the Fama-French and Carhart models. These estimates show that the coefficient on the cost of equity is consistently positive and statistically significant.

In summary, the results are robust to alternative measures and estimation methods. Adding pricing factors from the literature, as well as controlling for measurement error, does not fundamentally alter inferences regarding the impact of the cost of equity on corporate investment.

4.6. How Important Is Autocorrelation?

The treatment of time is a key concern in investment theory. What if there is a negative autocorrelation? Negative and positive autocorrelations might have rather different implications for sensible investment decisions. For example, under a negative autocorrelation, a high cost of capital today might imply a low cost in the future. The pattern of optimal investment could be altered. A negative autocorrelation in the cost of equity might account for the CAPM findings.

To examine this possibility, we estimate both AR(1) and AR(2) models on a firm-by-firm basis. We examine the autocorrelation of the WACC, the CAPM version of the cost of equity, and corporate cash flow. At the firm level, the number of years for which data are available is limited. Thus, attention is restricted to firms with at least 12 years of data. Because the autoregressions are estimated firm by firm, a huge number of coefficients are generated. Table 7 reports the values for the 25th percentile, the median, and the 75th percentile of the autocorrelation coefficients and t-statistics.

The statistical significance of the AR(1) results is not inconsequential, given the small samples and the requirement for non-overlapping data. A negative autocorrelation is not common for either cash flows or the cost of equity. The median firm has positively autocorrelated cash flows, and the coefficients are statistically significant ($t = 2.143$). The WACC and cost of equity are also generally positively autocorrelated. Allowing for an AR(2) process does not fundamentally alter the conclusion that a positive autocorrelation is the usual case. The second lag terms are not generally statistically significant. Very similar results are also obtained for the Fama-French and Carhart versions.

Table 7 shows that a positive autocorrelation is typical, but some variation can be found among firms. The cross-sectional autocorrelation differences in the cost of capital could affect the results. To examine the actual impact, we sort firms into quintiles based on the autocorrelations of WACC. In columns 5 and 6 of Table 5, the investment regression results are reported for the extreme quintiles. WACC has a stronger impact among the firms with a high positive autocorrelation, and the impact of the cost of equity is also stronger for such firms. The impacts of the cost of debt and the cost of equity are consistent with previous results for both categories of firms. We can find no real evidence that a negative autocorrelation in the cost of equity accounts for the findings.

4.7. Alternative Mechanisms

A clear positive connection can be found between the factor-model-based cost of equity measures and corporate investment. This impact on investment is robust but contradicts the model's predictions. To interpret this result, we explore some alternative ideas that have been suggested. It is possible that the theory is in need of some minor modification, or some important mechanisms may be completely missed in the model. On the other hand, also possible is that the factor-model-based cost of equity measures empirically pick up other effects that dominate the cost of capital effect, or these measures may fail to capture the effect.

One conjecture is that the shock processes might matter. Perhaps the results are driven by a covariance of the discount factor with productivity shocks. The model in the work of Abel and Blanchard (1986) assumes that shocks to profits and the discount factor are independent processes, but they could be driven by a common shock. For example, in equation 12, when r^S_{it+1} changes, Π_{it+1} normally changes as well. To explore this idea, we simulate the Zhang (2005) model. The model has an explicit covariance between the pricing kernel and productivity shocks. However, in the simulated data, the cost of equity and corporate investment are again negatively related. Therefore, this approach to potentially explaining the evidence is not presented in detail.

It appears that an alternative mechanism may be needed to account for the impact of the factor-model-based cost of equity measures. The existing literature already contains a number of candidates, and we have examined several of them. Possibilities that have been suggested include information feedback as in Chen, Goldstein, and Jiang (2007), managerial overinvestment as in Albagli, Hellwig, and Tsyvinski (2011), and misvaluation as in Warusawitharana and Whited (2014), among others. When exploring aspects of these alternative ideas, nothing definitive is obtained.

It is likely that the factor-model-based cost of equity measures empirically pick up other effects. Polk and Sapienza (2009) report a positive relation between discretionary accruals and corporate investment. Discretionary accruals are interpreted as a proxy for mispricing. The factor-model-based cost of equity measures may pick up this mispricing effect, so the impact on investment is positive. We test this idea using the CAPM version but find no supporting evidence.

Another possibility is that the true cost of capital effect is missing from the factors actually included. If so, then the residuals from the factor model estimate might help to explain corporate investment. Empirically, we include proxies for residuals in investment regressions.[7] The inclusion of these proxies does not change our basic results, and their own impact on investment is not robust or consistent.

5. Implied Cost of Equity Capital

The results in Table 6 show that considerable robustness is associated with the positive sign on the factor-model-based cost of equity measures in an investment regression. Because this sign contradicts the model, if one were to stop here, the conclusion would be that the model does not capture the main force that is at work. Before drawing such an inference,

[7] We use three proxies. The first is the difference between the realized annual return and the estimated expected return. The second is the absolute value of the first proxy. The third is $(1 - R^2)$ where the R^2 is taken from the regressions that we use to estimate expected returns.

however, we examine an alternative approach to measuring the cost of equity: the implied cost of equity capital.

The implied cost of equity capital is an increasingly popular alternative to the factor models such as the CAPM. There are several closely related alternative methods. We use the Gordon growth model and residual income model. In these models, the cost of equity is backed out from the current stock price and analyst earnings forecasts from the I/B/E/S data set. The Appendix provides the details of ICC variable construction. Further discussion of these methods can be found in the work of Gebhardt, Lee, and Swaminathan (2001), Lee, So, and Wang (2010), Hou, van Dijk, and Zhang (2012), and Pastor, Sinha, and Swaminathan (2008). Tang, Wu, and Zhang (2014) provide some evidence on the difference between average returns and the implied cost of equity.

The correlations among a number of proxies for the cost of equity and realized equity returns are reported in Table 8. The data are grouped into i) realized equity returns, ii) the factor-model-based cost of equity measures, including the version of CAPM, Fama-French, and Carhart, and iii) the implied cost of equity from models including the Gordon growth one-period model, the Gordon growth five-period model, and the residual income model following the method in the work of Chava and Purnanandam (2010).

As expected, the factor-model-based costs of equity measures are highly correlated, with correlations of about 0.65. The various implied cost of equity measures are also highly correlated with one another, with correlations of about 0.75. The correlations across the three groups are much smaller. The correlation between a factor-model-based cost of equity and a realized equity return is about 0.1. The correlation between an implied cost of equity and the realized returns is essentially zero. No correlation can be found between the CAPM version of the cost of equity and the implied cost of equity. For the Fama-French and the Carhart versions, the correlation with the implied cost of equity is about 0.1. The correlations show that the factor models and the implied cost of equity models are distinct. These proxies for the cost of equity do not appear to be alternative reflections of the same underlying mechanism.

The next question is how the implied cost of equity works in an investment regression. The results from the implied cost of equity are reported in Table 9. We see that these measures make a major difference. In Table 9, the first three columns provide investment regression results that correspond to those in Table 2. Columns 4 to 6 present a decomposition of the cost of equity that corresponds to that in Table 3. For completeness columns 7 to 9 extend the results from columns 4 to 6 by adding the CAPM version of the cost of equity as another explanatory variable.

Columns 1 to 3 show that each of the implied cost of equity estimates generates a WACC that has a negative and significant sign in the investment regression. All three of these estimates have a similar ability to explain the variation in the data. The estimates explain somewhat more of the variation in the data than do the estimates in Table 2. For the GGM1 version, a one standard deviation increase in the WACC is associated with a 7.6% decrease in the investment-capital ratio. Columns 4 to 6 show the results of decomposing the WACC into cost of equity and cost of debt terms, similar to that shown in Table 3. The coefficients on the cost of debt are similar to those reported in Table 3. The coefficients on the cost of equity are opposite to those reported in Table 3. The cost of equity now has a negative association with corporate investment. A one standard deviation increase in the equity group of terms is associated with a 4.5% decrease in the investment-capital ratio and explains the results shown in columns 1 to 3. The specifications in columns 4 to 6 explain more of the variation than that found in Table 3.

A key justification for using the ICC methods is provided by Pastor, Sinha, and Swaminathan (2008). Their theoretical analysis assumes that both the dividend growth and the conditional expected returns follow an AR(1) process. They show that the ICC is then an affine function of the conditional expected return. Therefore, the two are perfectly correlated, and thus the ICC is able to capture the time variation in expected return.

Recall that to derive the testable equation 11, we assume that both the cash flow and the cost of capital follow an AR(1) process. The cash flow and the cost of capital correspond to the dividend and the expected return in the work of Pastor, Sinha, and Swaminathan (2008). The cost of capital dynamics in our setting is the same as the expected return process in the work of Pastor, Sinha, and Swaminathan (2008). This result provides a natural reason for why the ICC should be a good proxy for the cost of capital in our setting. The relation between optimal investment and the cost of capital is essentially driven by how the current cost of capital reflects the future changes. The variation along the time dimension is exactly what the ICC should capture according to Pastor, Sinha, and Swaminathan (2008).

The results in Table 8 and from the first six columns of Table 9 show that the implied cost of equity affects investment differently than does the cost of equity obtained from the factor models. Does this finding mean that the factor-model-based measures are actually just noisy approximations, whereas the ICC estimates are simply better? If this is true, then when both are included in the same investment regression, the factor-model-based estimates should generally have statistically insignificant coefficients.

In columns 7 to 9 of Table 9, we include the CAPM version of the cost of equity along with the ICC estimates. Both the implied cost of equity and the CAPM version of the cost of equity are statistically significant, and both have the same signs as when introduced without the other. Neither variable subsumes the impact of the other. In other words, these are not good proxies for each other, and both appear to be related to corporate investment.

This section has important implications for how we view the model and for empirical approaches to investment. The model predicts that firms with a high cost of equity and a high cost of debt invest less. Both of these predictions are supported when the ICC is used to proxy for the cost of equity. This is good news for the model.

As has been argued by Pastor, Sinha, and Swaminathan (2008), ICC-based measures should provide a good reflection of the time-varying required return on equity. Our evidence is naturally interpreted as supporting their perspective. The ICC seems very useful.

Going beyond the model predictions, the CAPM version of the cost of equity has an impact on investment that is statistically significant, quite robust, but with the opposite of the model predicted sign. It provides information that is related to corporate investment, but it operates through a mechanism that is not present in the model. As suggested in Section 4.7, the idea that this mechanism might be connected to misvaluation seems worthy of future investigation.

6. Conclusion

At least since the work of Abel and Blanchard (1986), the understanding is that corporate investment ought to reflect the impact of the cost of capital. Because firms are financed by both debt and equity, both of these factors ought to matter. Little support for the idea can be found the in aggregate data, as shown by Abel and Blanchard (1986) and Kothari, Lewellen, and Warner (2014). Because the theory is at the firm level, it is natural to consider firm-level tests. Yet in the literature, firm-level data on this issue are largely unexamined.

Our paper undertakes that investigation and discovers that the predicted impact of the cost of debt is observed in the data. However, the impact of the cost of equity is more complex than anticipated. Contrary to the model, empirically firms with a high cost of equity, as measured by factor models including the CAPM, have high investment. Consistent with the model, firms with a high cost of equity as measured by the ICC, have low investment.

The interpretation of the results requires care. Both the ICC-based and the factor-model-based cost of equity measures provide independent and empirically important information for corporate investment. The ICC results provide support for the work of Abel and Blanchard (1986) under the interpretation that the ICC measures time-varying expected equity returns. The connection between the factor-model-based cost of equity measures and corporate investment deserves further study and a full account of that relationship may have implications that extend beyond our focus on the impact of the cost of capital on corporate investment.

Appendix

The accounting data are from the CRSP/Compustat merged database. The data of stock returns are from CRSP. The sample period is from 1955 to 2011. Foreign companies and companies with an SIC code that is between 4900 and 4999 or between 6000 and 6999 are dropped. Also dropped are the firms with a negative average cash flow. All variables, including various cost of capital measures discussed below, are winsorized at a 1% level on each tail every year. Item names refer to Compustat annual data items. The cost of equity and debt estimates are deflated so that they are in real terms. The negative cost of equity is set to missing.

Variable	Definition
Investment	(Item CAPX - Item SPPE)/ Item PPENT. Data Item PPENT is lagged.
Market-to-book	(Item AT + Item PRCC×Item CSHO - Item SEQ - Item TXDB)/ Item AT
Cash flow	(Item OIBDP)/Item PPENT. Data Item PPENT is lagged.
Market leverage	(Item DLTT + Item DLC)/(Item AT + Item PRCC×Item CSHO - Item SEQ - Item TXDB)
Firm size	The logarithm of the Item TA is in 2004 dollars
Tax	Item TXT/ Item PI. This value is set to missing if it is above one or below zero.

Variable	Definition
Cost of Debt	
Average cost of debt	Item XINT/(Item DLTT + Item DLC)
Corporate bond returns	Following the work of Liu, Whited, and Zhang (2009), we first impute bond ratings not available in Compustat and then assign the corporate bond returns for a given credit rating as the corporate bond returns to all the firms with the same credit rating.
Cost of Equity	
CAPM	The $r_{E,CAPM}$ is the cost of equity from the CAPM. Daily stock returns in each calendar year are used to estimate firm β. The dependent variable is the excess stock return, and the independent variable is the Fama-French market excess return. $r_{E,CAPM} = r_f + \beta E(r_M - r_f)$. The risk-free rate r_f is the 10-year Treasury yield from FRED. $E(r_M - r_f)$ is the historical mean of the Fama-French market excess return; that is, the date t equity premium is the average of the Fama-French market excess return from time t to time 1. We also estimate the firm β using the past 3 or 5 years of monthly stock returns as a robustness check.
FF3	The $r_{E,FF3}$ is the cost of equity from the Fama-French 3-factor model. It is estimated in a similar way as the $r_{E,CAPM}$.
Car	The $r_{E,Car}$ is the cost of equity from the Carhart 4-factor model. It is estimated in a similar way as the $r_{E,CAPM}$.

Variable	Definition
IST	We add the investment specific technology (IST) shock factor into the Carhart 4-factor model. We calculate the cost of equity using firm monthly stock returns in the past 5 years. The monthly IST shock factor data are from from 1952/1 to 2008/12. This factor is proposed and used by Kogan and Papanikolaou (2013).
PMU	We add the profitable-minus-unprofitable (PMU) factor into the Carhart 4-factor model. We calculate the cost of equity using firm monthly stock returns in the past 5 years. The monthly PMU factor data are from 1963/7 to 2012/12. This factor is proposed and used by Novy-Marx (2013).
GMM	We construct two implied cost of equity measures from the Gordon growth model. The $r_{E,GGM1}$ is the cost of equity from a one-period Gordon growth model, and it is computed from the equation $P_t = \frac{EPS_{t+1}}{r_{E,GGM1}}$, where P_t is the stock price. The $r_{E,GGM5}$ is the cost of equity from a five-period Gordon growth model, and it is numerically solved from the following equation: $P_t = \sum_{i=1}^{4} \frac{DPS_{t+i}}{(1+r_{E,GGM5})^i} + \frac{EPS_{t+5}}{r_e(1+r_{E,GGM5})^4}$, with $DPS_{t+1} = EPS_{t+1} \times \kappa$. The dividend payout ratio, κ, follows the work of Hou et al. (2012) and Gebhardt et al. (2001): if earnings are positive, κ is the current dividends divided by current earnings; if earnings are negative, κ is the current dividends divided by $0.06 \times$ *total assets*.

Variable	Definition
CP	$r_{E,CP}$ follows the work of Chava and Purnanandam (2010); the details can be found in their Appendix A.3.

References

Abel, A., Blanchard, O., 1986. The present value of profits and cyclical movements in investment. Econometrica 54, 249–273.

Albagli, E., Hellwig, C., Tsyvinski, A., 2011. Information aggregation, investment, and managerial incentives. Working paper .

Campbell, J. Y., Shiller, R. J., 1988. The dividend-price ratio and expectations of future dividends and discount factors. Review of Financial Studies 1, 195–228.

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

Carlson, M., Fisher, A., Giammarino, R., 2004. Corporate investment and asset price dynamics: Implications for the cross-section of returns. Journal of Finance 59, 2577–2603.

Carlson, M., Fisher, A., Giammarino, R., 2006. Corporate investment and asset price dynamics: Implications for seo event studies and long-run performance. Journal of Finance 61, 1009–1034.

Chava, S., Purnanandam, A., 2010. Is default risk negatively related to stock returns? Review of Financial Studies 23, 2523–2559.

Chen, H., Chen, S., 2012. Investment-cash flow sensitivity cannot be a good measure of financial constraints: Evidence from the time series. Journal of Financial Economics 103, 393–410.

Chen, Q., Goldstein, I., Jiang, W., 2007. Price informativeness and investment sensitivity to stock price. Review of Financial Studies 20, 619–650.

Erickson, T., Jiang, C. H., Whited, T. M., 2014. Minimum distance estimation of the errors-in-variables model using linear cumulant equations. Journal of Econometrics 183, 211–221.

Erickson, T., Whited, T., 2000. Measurement error and the relationship between investment and q. Journal of Political Economy 108, 1027–1057.

Fama, E., French, K., 1993. Common risk factors in the returns on stocks and bonds. Journal of Financial Economics 33, 3–56.

Fazzari, S., Hubbard, R., Petersen, B., 1988. Financing constraints and corporate investment. Brookings Papers on Economic Activity 1, 141–206.

Frank, M., Goyal, V., 2009. Capital structure decisions: Which factors are reliably important? Financial Management 38, 1–37.

Gebhardt, W., Lee, C., Swaminathan, B., 2001. Toward an implied cost of capital. Journal of Accounting Research 39, 135–176.

Gilchrist, S., Himmelberg, C., 1995. Evidence on the role of cash flow for investment. Journal of Monetary Economics 36, 541–572.

Gilchrist, S., Zakrajsek, E., 2007. Investment and the cost of capital: New evidence from the corporate bond market. Working paper .

Gilchrist, S., Zakrajšek, E., 2012. Credit spreads and business cycle fluctuations. American Economic Review 102, 1692–1720.

Gilson, S. C., Hotchkiss, E. S., Ruback, R. S., 2000. Valuation of bankrupt firms. Review of Financial Studies 13, 43–74.

Graham, J., Mills, L., 2008. Using tax return data to simulate corporate marginal tax rates. Journal of Accounting and Economics 46, 366–388.

Harvey, C., Liu, Y., Zhu, H., 2013. . . . and the cross-section of expected returns. Working paper .

Hou, K., van Dijk, M. A., Zhang, Y., 2012. The implied cost of capital: A new approach. Journal of Accounting and Economics 53, 504–526.

Kaplan, S. N., Ruback, R. S., 1995. The valuation of cash flow forecasts: An empirical analysis. Journal of Finance 50, 1059–1093.

Kogan, L., Papanikolaou, D., 2013. Firm characteristics and stock returns: The role of investment-specific shocks. Review of Financial Studies 26, 2718–2759.

Kothari, S., Lewellen, J., Warner, J. B., 2014. The behavior of aggregate corporate investment. Working paper .

Lee, C., So, E., Wang, C., 2010. Evaluating implied cost of capital estimates. Working paper .

Lewellen, J., 2010. Accounting anomalies and fundamental analysis: An alternative view. Journal of Accounting and Economics 50, 455–466.

Li, Y., Ng, D. T., Swaminathan, B., 2013. Predicting market returns using aggregate implied cost of capital. Journal of Financial Economics 110, 419–436.

Lin, X., Zhang, L., 2013. The investment manifesto. Journal of Monetary Economics 60, 351–366.

Liu, L., Whited, T., Zhang, L., 2009. Investment-based expected stock returns. Journal of Political Economy 117, 1105–1139.

Ludvigson, S., Ng, S., 2009. Macro factors in bond risk premia. Review of Financial Studies 22, 5027–5067.

Novy-Marx, R., 2013. The other side of value: The gross profitability premium. Journal of Financial Economics 108, 1–28.

Pastor, L., Sinha, M., Swaminathan, B., 2008. Estimating the intertemporal risk–return tradeoff using the implied cost of capital. Journal of Finance 63, 2859–2897.

Philippon, T., 2009. The bond market's q. Quarterly Journal of Economics 124, 1011–1056.

Polk, C., Sapienza, P., 2009. The stock market and corporate investment: A test of catering theory. Review of Financial Studies 22, 187–217.

Strebulaev, I. A., Yang, B., 2013. The mystery of zero-leverage firms. Journal of Financial Economics 109, 1–23.

Tang, Y., Wu, J. G., Zhang, L., 2014. Do anomalies exist *exante*? Review of Finance 18, 843–875.

Warusawitharana, M., Whited, T. M., 2014. Equity market misvaluation, financing, and investment. Working paper .

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

Table 1: Descriptive Statistics

This table presents the descriptive statistics of the main variables in the paper. The accounting data are from the CRSP/Compustat merged database. The data of stock returns are from CRSP. The sample period is from 1955 to 2011. Foreign companies, companies with an SIC code that is between 4900 and 4999 or between 6000 and 6999, and the firms with a negative average cash flow are dropped. The net capital stock K is Item PPENT. Market-to-book ratio ($Mktbk$) is (Item AT + Item PRCC×Item CSHO - Item SEQ -Item TXDB)/ Item AT. Cash flow ($CashFlow$) is Item OIBDP. Capital expenditure I is (Item CAPX - Item SPPE). Data Item PPENT is lagged. $r_{E,CAPM}$ is the cost of equity from CAPM model. $r_{E,FF3}$ is the cost of equity from the Fama-French three-factor model. $r_{E,Car}$ is the cost of equity from the Carhart four-factor model. The cost of equity is calculated using firm daily stock returns in each calendar year. The market leverage Lev is (Item DLTT+ Item DLC)/(Item AT + Item PRCC×Item CSHO - Item SEQ -Item TXDB). Tax is the corporate average tax rate, which is Item TXT/ Item PI. This value is set to missing if it is above one or below zero. r_D is the average cost of debt, which is Item XINT/(Item DLTT + Item DLC). Item names refer to Compustat data items. All variables are winsorized at a 1% level on each tail every year. The cost of equity and debt estimates are deflated so that they are in real terms. $wacc_{CAPM} = r_{E,CAPM} \times (1 - Lev) + r_D \times Lev \times (1 - Tax)$, $wacc_{FF3} = r_{E,FF3} \times (1 - Lev) + r_D \times Lev \times (1 - Tax)$, and $wacc_{Car} = r_{E,Car} \times (1 - Lev) + r_D \times Lev \times (1 - Tax)$.

	n	mean	std.	p25	median	p75
I/K	133726	0.306	0.378	0.115	0.206	0.361
$CashFlow/K$	135588	0.897	1.707	0.256	0.517	1.005
$r_{E,CAPM}$	134657	0.166	0.095	0.096	0.154	0.221
$r_{E,FF3}$	134291	0.228	0.124	0.139	0.214	0.301
$r_{E,Car}$	128683	0.232	0.143	0.128	0.210	0.311
r_D	110996	0.086	0.218	0.027	0.049	0.078
Lev	145739	0.214	0.190	0.048	0.173	0.332
$Mktbk$	135785	1.601	1.294	0.954	1.214	1.786
Tax	133064	0.355	0.154	0.300	0.385	0.459
$wacc_{CAPM}$	93697	0.139	0.080	0.081	0.126	0.181
$wacc_{FF3}$	93144	0.187	0.102	0.114	0.172	0.242
$wacc_{Car}$	89561	0.191	0.119	0.105	0.170	0.251
number of firms	9714		average years	24.25		

Table 2: Investment Regressions with WACC

This table reports the estimates from the panel regressions. See the Appendix for variable details. The first row indicates the version of cost of equity in the WACC. In columns 1 to 3, the contemporaneous measures of the WACC and cash flows are used. In columns 4 to 6, the one-year lagged measures of the WACC and cash flows are used. The firm and year fixed effects are included. The standard errors are clustered both by firm and by year.

	(1) CAPM	(2) FF3	(3) Car	(4) CAPM, t-1	(5) FF3, t-1	(6) Car, t-1
$CashFlow/K$	0.081***	0.083***	0.082***	0.059***	0.061***	0.060***
	(11.14)	(11.16)	(10.66)	(11.25)	(10.90)	(10.31)
$wacc$	0.371***	0.138***	0.138***	0.387***	0.243***	0.251***
	(9.56)	(6.22)	(6.94)	(13.12)	(11.50)	(13.05)
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Two-way Clustered	Yes	Yes	Yes	Yes	Yes	Yes
N	87266	86711	83305	80833	80399	77331
Adj. R^2	0.343	0.345	0.349	0.311	0.308	0.318

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Decomposing WACC

This table reports the estimates from the panel regressions. See the Appendix for variable details. The first row indicates the version of the cost of equity. The firm and year fixed effects are included. The standard errors are clustered both by firm and by year.

	(1) CAPM	(2) CAPM	(3) CAPM	(4) Car	(5) Car	(6) Car
$CashFlow/K$	0.075***	0.069***	0.072***	0.076***	0.069***	0.072***
	(11.03)	(10.83)	(10.67)	(10.49)	(10.33)	(10.21)
$(1 - Tax) \times Lev \times r_D$	-5.252***	-4.419***		-5.743***	-4.665***	
	(-14.03)	(-12.84)		(-17.30)	(-14.82)	
$(1 - Lev) \times r_E$	0.341***	0.153***		0.110***	0.061***	
	(8.77)	(5.10)		(5.90)	(3.78)	
$Mktbk$		0.073***	0.077***		0.073***	0.078***
		(15.74)	(15.30)		(15.53)	(15.26)
Lev			-0.089***			-0.084***
			(-5.16)			(-4.95)
r_D			-0.064***			-0.060***
			(-4.62)			(-4.27)
Tax			0.022*			0.017
			(1.70)			(1.24)
r_E			0.162***			0.054***
			(8.07)			(4.37)
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Two-way Clustered	Yes	Yes	Yes	Yes	Yes	Yes
N	87266	87266	87266	83305	83305	83305
Adj. R^2	0.361	0.388	0.372	0.366	0.394	0.379

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Across the Decades

This table reports the estimates from the panel regressions in different decades. See the Appendix for variable details. The first row indicates the sample period. The CAPM version of the cost of equity is used. The firm and year fixed effects are included. The standard errors are clustered both by firm and by year.

	70-79	80-89	90-99	00-11
$CashFlow/K$	0.117***	0.145***	0.095***	0.044***
	(12.12)	(11.39)	(12.51)	(7.52)
$wacc_{CAPM}$	0.100***	0.384***	0.436***	0.426***
	(3.01)	(4.08)	(10.93)	(3.52)
Year Fixed Effect	Yes	Yes	Yes	Yes
Firm Fixed Effect	Yes	Yes	Yes	Yes
Two-way Clustered	Yes	Yes	Yes	Yes
N	13985	21314	23271	19122
Adj. R^2	0.417	0.339	0.471	0.456

$CashFlow/K$	0.109***	0.134***	0.088***	0.042***
	(12.02)	(10.86)	(12.12)	(7.26)
$(1 - Tax) \times Lev \times r_D$	-5.402***	-6.403***	-6.124***	-2.958***
	(-7.60)	(-9.97)	(-16.76)	(-5.10)
$(1 - Lev) \times r_{E,CAPM}$	0.089***	0.352***	0.425***	0.433***
	(2.78)	(4.12)	(10.94)	(3.53)
Year Fixed Effect	Yes	Yes	Yes	Yes
Firm Fixed Effect	Yes	Yes	Yes	Yes
Two-way Clustered	Yes	Yes	Yes	Yes
N	13985	21314	23271	19122
Adj. R^2	0.426	0.359	0.487	0.465

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Differences among Firms

This table reports the estimates from the panel regressions. See the Appendix for variable details. Columns (1) and (2) report the estimates for the subsample with market leverage above and below 0.05. In each year, all firms are sorted into quintiles by their total assets. Columns (3) and (4) report the estimates for the largest and smallest firms. For each firm with at least 12 observations, the autocorrelations of $wacc_{CAPM}$ are computed. All firms are sorted into quintiles by their coefficients of autocorrelation. Columns (5) and (6) report the estimates for the firms with the lowest(negative) and largest (positive) coefficients. The firm and year fixed effects are included. The standard errors are clustered both by firm and by year.

	Market Leverage		Firm Size		Autocorrelation	
	Below 5%	Above 5%	Small	Large	Low	High
$CashFlow/K$	0.080***	0.081***	0.064***	0.070***	0.087***	0.099***
	(12.41)	(8.59)	(9.40)	(3.83)	(6.07)	(4.98)
$wacc_{CAPM}$	0.472***	0.260***	0.276***	0.368***	0.161***	0.324***
	(7.19)	(7.60)	(4.10)	(6.16)	(2.83)	(5.32)
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Two-way Clustered	Yes	Yes	Yes	Yes	Yes	Yes
N	13202	72671	15088	16513	9718	9817
Adj. R^2	0.458	0.316	0.259	0.443	0.242	0.299

$CashFlow/K$	0.078***	0.075***	0.059***	0.069***	0.079***	0.094***
	(12.36)	(8.44)	(8.99)	(3.76)	(5.56)	(4.86)
$(1 - Tax) \times Lev \times r_D$	-14.382***	-5.226***	-6.536***	-2.453*	-5.002***	-3.594***
	(-5.30)	(-13.30)	(-13.83)	(-1.80)	(-13.30)	(-6.61)
$(1 - Lev) \times r_{E,CAPM}$	0.466***	0.246***	0.286***	0.340***	0.149***	0.280***
	(7.11)	(7.36)	(4.42)	(5.31)	(2.66)	(4.79)
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Two-way Clustered	Yes	Yes	Yes	Yes	Yes	Yes
N	13202	72671	15088	16513	9718	9817
Adj. R^2	0.463	0.338	0.282	0.448	0.262	0.311

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Alternative Measures and Estimation Method

This table reports the estimates from alternative measures of the cost of capital and an alternative estimation method. See the Appendix for variable details. Columns (1) to (3) report the estimates from the panel regressions. The cost of equity is calculated using firm monthly stock returns in the past five years. In column (1), $r_{E,CAPM}$ is the cost of equity from the CAPM model. r_D is the bond returns for different rating classes of bonds. In column (2) and (3), either the investment specific technology (IST) shock factor or the profitable-minus-unprofitable (PMU) factor is added into the Carhart four-factor model to estimate $r_{E,IST}$ and $r_{E,PMU}$. r_D is the average cost of debt, which is Item XINT/(Item DLTT + Item DLC). In columns (1) to (3), the firm and year fixed effects are included. The standard errors are clustered both by firm and by year. In columns (4) to (6), the main measures of the cost of capital are used, and the model is estimated by the high-order cumulant estimators for one mismeasured regressor as in the work of Erickson, Jiang, and Whited (2014). A within transformation is performed on all variables, and the results are based on the fourth-order cumulant estimator. Results from using the third-, fifth-, and sixth-order estimators are qualitatively similar. The $(1 - Lev) \times r_E$ is treated as the mismeasured variable. ρ^2 is an estimate of the R^2 of the regression. τ^2 is an index of measurement quality for the proxy for $(1 - Lev) \times r_E$. Standard errors are in parentheses under the parameter estimates. The second row indicates the version of the cost of equity in the WACC.

	Alternative Measures				Alternative Estimation Method		
	(1)	(2)	(3)		(4)	(5)	(6)
	CAPM	IST	PMU		CAPM	FF3	Car
$CashFlow/K$	0.079***	0.074***	0.071***		0.053***	0.072***	0.060***
	(9.33)	(7.11)	(8.21)		(21.57)	(28.81)	(23.38)
$(1 - Tax) \times Lev \times r_D$	-0.424***	-4.283***	-4.289***		0.205	-3.122***	-2.291***
	(-3.06)	(-14.28)	(-15.63)		(0.57)	(-10.07)	(-7.15)
$(1 - Lev) \times r_E$	0.240***	0.107***	0.079***		2.220***	0.997***	1.059***
	(4.20)	(4.33)	(3.79)		(12.58)	(7.40)	(11.26)
Year Fixed Effect	Yes	Yes	Yes	ρ^2	0.204***	0.158***	0.163***
Firm Fixed Effect	Yes	Yes	Yes		(26.24)	(24.91)	(25.12)
Two-way Clustered	Yes	Yes	Yes	τ^2	0.085***	0.044***	0.057***
Adj. R^2	0.304	0.341	0.338		(14.95)	(10.11)	(13.20)
N	52245	60182	58424	N	87936	87414	84100

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Firm-Level Evidence of the Impact of Autocorrelation

For each firm i, two pure time series equations are estimated:

$$Y_{i,t} = \beta_1 Y_{i,t-1} + \varepsilon_{i,t}$$

$$Y_{i,t} = \beta_{21} Y_{i,t-1} + \beta_{22} Y_{i,t-2} + \varepsilon_{i,t} \ .$$

The firms in the sample are required to have at least 12 observations. The variable Y is at an annual frequency and could be $r_{E,CAPM}$, $wacc_{CAPM}$, or cash flow. For each firm i and each Y, the β is recorded. The summary statistics of β are reported, and cross-sectional distribution is shown in the 25th percentile (p25) to 75th percentile (p75). See the Appendix for variable details.

			Coefficients			T-statistics		
		n	p25	p50	p75	p25	p50	p75
$wacc_{CAPM}$	β_1	1859	0.260	0.450	0.607	1.148	2.143	3.463
	β_{21}	1859	0.204	0.406	0.592	0.763	1.589	2.437
	β_{22}	1859	-0.138	0.032	0.207	-0.504	0.128	0.832
$r_{E,CAPM}$	β_1	3641	0.201	0.398	0.567	0.898	1.984	3.300
	β_{21}	3641	0.183	0.368	0.534	0.753	1.641	2.546
	β_{22}	3641	-0.129	0.027	0.168	-0.542	0.115	0.766
$Cashflow/K$	β_1	3771	0.435	0.622	0.763	2.138	3.677	5.856
	β_{21}	3771	0.435	0.665	0.876	1.801	2.933	4.266
	β_{22}	3771	-0.283	-0.121	0.047	-1.287	-0.529	0.216

Table 8: Correlations among Costs of Equity and Realized Equity Returns

This table reports the correlation matrix of different measures of the cost of equity. See the Appendix for variable details. The cost of equity is calculated using firm daily stock returns in each calendar year. Three implied cost of equity measures are considered. $r_{E,GGM1}$ is the cost of equity from a one-period Gordon growth model, and $r_{E,GGM5}$ is the cost of equity from five-period Gordon growth model. The $r_{E,CP}$ follows the measure in the work of Chava and Purnanandam (2010). Earnings forecasts are from I/B/E/S. The cost of equity and realized returns are in real terms.

	ret	$r_{E,CAPM}$	$r_{E,FF3}$	$r_{E,Car}$	$r_{E,GGM1}$	$r_{E,GGM5}$	$r_{E,CP}$
ret	1.00						
$r_{E,CAPM}$	0.08**	1.00					
$r_{E,FF3}$	0.07**	0.65**	1.00				
$r_{E,Car}$	0.11**	0.52**	0.78**	1.00			
$r_{E,GGM,1}$	0.01*	0.00	0.06**	0.03**	1.00		
$r_{E,GGM}$	-0.01	-0.00	0.10**	0.06**	0.78**	1.00	
$r_{E,CP}$	-0.03**	-0.01**	0.11**	0.07**	0.69**	0.83**	1.00

* $p < 0.05$, ** $p < 0.01$

Table 9: Implied Cost of Equity

This table reports the estimates from the panel regressions. See the Appendix for variable details. The first row indicates the version of the cost of equity. The firm and year fixed effects are included. The standard errors are clustered both by firm and by year.

	(1) GGM1	(2) GGM5	(3) CP	(4) GGM1	(5) GGM5	(6) CP	(7) GGM1	(8) GGM5	(9) CP
$CashFlow/K$	0.066***	0.064***	0.072***	0.061***	0.059***	0.066***	0.061***	0.058***	0.064***
	(6.53)	(5.57)	(6.22)	(6.43)	(5.38)	(6.04)	(6.38)	(5.36)	(6.01)
$wacc$	-0.468***	-0.574***	-0.224***						
	(-5.96)	(-9.66)	(-6.79)						
$(1 - Tax) \times Lev \times r_D$				-5.210***	-6.150***	-6.249***	-5.303***	-6.011***	-5.895***
				(-11.84)	(-12.52)	(-14.99)	(-14.75)	(-15.21)	(-17.29)
$(1 - Lev) \times r_E$				-0.279***	-0.420***	-0.175***	-0.277***	-0.419***	-0.195***
				(-3.69)	(-8.08)	(-5.17)	(-3.57)	(-8.14)	(-5.83)
$(1 - Lev) \times r_{E,CAPM}$							0.230***	0.317***	0.384***
							(4.90)	(7.25)	(8.54)
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Two-way Clustered	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	26367	27548	33048	26367	27548	33048	26058	27311	32716
Adj. R^2	0.448	0.456	0.447	0.462	0.472	0.465	0.467	0.477	0.472

t statistics in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$