Investment and the Weighted Average Cost of Capital

Murray Z. Frank and Tao Shen*

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Abstract

Empirical studies of corporate investment focus on Q, cash flow and financial constraints. Textbooks focus on the Net Present Value of an investment using the weighted average cost of capital (WACC). To reconcile the approaches we include WACC in standard investment regressions, using 440 alternative implementations of the WACC for U.S. firms from 1960 to 2010. CAPM and Implied Cost of Capital are popular ways to estimate the cost of equity, which is a key component of WACC. However, they have opposite effects in investment regressions. This difference can be traced back to implicit theoretical assumptions. Some well-known financial constraint indices are closely related to WACC.

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[*] Murray Z. Frank, Piper Jaffray Professor of Finance, University of Minnesota, Minneapolis, MN 55455. Tao Shen, Department of Finance, University of Minnesota, Minneapolis, MN 55455. We are grateful to an anonymous referee, Heitor Almeida, Philip Bond, Bob Goldstein, Cam Harvey, Laura Liu, Raj Singh, Andy Winton, Toni Whited, and seminar participants at the University of Minnesota, North Carolina State, Cheung Kong Graduate School of Business, Shanghai Advanced Institute for Finance, and the CEPR meetings at Gerzensee for helpful comments and suggestions. We also thank Ken French and John Graham for making useful data available. We alone are responsible for any errors.

Corporate investment is treated in two seemingly disconnected ways in finance. The academic investment literature studies the effects of Q, cash flow, and financial constraints. However, for decades business students have been taught to evaluate investments by projecting cash flows and discounting them using the weighted average cost of capital (WACC).[1] In surveys such as Graham and Harvey (2001) and more recently AFP (2011), many financial managers say that they do this. If so, then WACC ought to affect investment, despite the neglect of WACC in scholarly studies of corporate investment. How do we reconcile these two, well-established approaches?

In this paper we study how the two approaches are related to each other. Empirically we do this by studying the impact of WACC, in investment regressions using U.S. data from 1960 to 2010. Theoretically we do this by showing how the model of Liu et al. (2009) can be used to interpret the evidence from the investment regressions. We also show how popular empirical proxies for financial constraints are related to the WACC.

The first hurdle is that we need to measure the WACC. The textbooks assert that this is easy to do.[2] In a sense it is too easy. The WACC is composed of the cost of equity, the cost of debt, the corporate leverage ratio, and the corporate tax rate. Each of these concepts can be measured in a wide range of seemingly plausible ways. We investigated 440 versions of the WACC for each firm in each year. For some seemingly plausible versions the average WACC is as high as 19.2% for other equally plausible versions it as low as 5.3%. So the measurement choices really matter even within the WACC/Free Cash Flow framework.

To understand this, note that the typical firm uses about 25% debt finance and 75% equity finance. So the return on equity is important, and the return on equity is more

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[1] Myers (1974) already referred to the WACC as 'the textbook formula.' The approach is taught by most modern corporate finance textbooks such as Benninga (2008), Berk and DeMarzo (2011), Brealey et al. (2006), Damodaran (2002), Graham et al. (2010), Koller et al. (2010), and Ross et al. (2008).

[2] "You can often use stock market data to get an estimate of r_E, the expected return demanded by investors in the company's stock. With that estimate, WACC is not too hard to calculate, because the borrowing rate r_D and the debt and equity ratios D/V and E/V can be directly observed or estimated without too much trouble." Brealey et al. (2006), page 514.

volatile than the return on debt. As a result it is not surprising that a great deal hinges on how we measure the required return on equity.

To measure the required return on equity, the leading finance textbooks teach students to use the CAPM.[3] In surveys practitioners report that they use the CAPM, although there seems to be a growing interest in the Fama-French factors and in the imputed methods based cost of equity. Of course, the academic literature is critical of the pure CAPM.

We group the methods used to measure the required return on equity into two categories that we label "stock return based methods" and "imputed methods". The stock-return methods that we study include several implementations of the CAPM, the Fama-French three-factor model, and the Fama-French four-factor model (also known as the Carhart model). The imputed methods that we study include several versions of the Gordon Growth Model (GGM) and several versions of the Residual Income Model developed by Gebhardt et al. (2001) or GLS model.

When the stock-return methods are used to estimate the required return on equity, then in an investment regression the WACC often has a positive coefficient. This is surprising if the WACC is reflecting the opportunity cost of investing. When the imputed methods are used, then in an investment regression the WACC has a negative coefficient.

Why do alternative proxies for the same concept – cost of equity – produce systematically different answers? A key purpose of our paper is to verify that this puzzling difference is empirically robust, and then to explain it both empirically and in theoretical terms. This helps to clarify the relationship between the two approaches to corporate investment.

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[3] “in addition to being very practical and straightforward to implement, the CAPM-based approach is very robust. While perhaps not perfectly accurate, when the CAPM does generate errors, they tend to be small. Other methods, such as relying on average historical returns, can lead to much larger errors.” Berk and DeMarzo (2011), page 399.

In the textbooks the WACC is the cost of capital. High cost is to be avoided.[4] Thus less investment should be undertaken by a high cost firm. From the textbook perspective this suggests favoring the imputed methods over the stock-return methods. However, this is not the only way to think about the problem.

In most academic models of investment the WACC is generally nowhere to be found. It is neither a state variable, nor a choice variable. It is a mixture of things. A useful way to clarify the connection is provided by Liu et al. (2009). They provide an equation that relates the return on investment to WACC.

Empirically we decompose the WACC and use the individual elements in investment regressions. The cost of debt has a negative sign. The stock-return versions of the cost of equity have a positive sign. The imputed versions of the cost of equity have a negative coefficient. The stock-return versions of WACC are thus a weighted sum of positive and negative effects. The imputed versions of WACC are much more empirically robust because they are generally a weighted sum of only negative effects. In other words, it really is a difference between the two classes of approaches to measuring the return on equity that is critical. So we need to understand why this happens.

In the model a high return on equity is associated with high investment. The return on equity is not an exogenous opportunity cost. The return on equity reflects the market expectations of the firm's cash flows, among other things. A firm will tend to invest when the opportunities improve. When that happens the market will tend to recognize that it is happening, and so the stock price for the firm will tend to rise. Thus in Liu et al. (2009) high investment tends to be positively associated with high stock returns. This provides a theoretical interpretation for the observed positive effect of the stock-return based WACC in an investment regression.

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[4] "The WACC is of critical importance to almost all firms. Companies that use the WACC to evaluate real investments know that a higher WACC implies investments must pass a higher hurdle before they can generate shareholder wealth." Graham et al. (2010) page 321.

However, if this model is the right way to think about the problem, how does it suggest interpreting the imputed versions of WACC? The construction of these versions of the WACC effectively assume that the return on equity is the same year-after-year for at least a few years. Without this the imputation is hard to carry out.

To get this out of the Liu et al. (2009) model it is natural to assume that the investor is risk-neutral. If the investor is risk-neutral then the expected stock return or the cost of equity computed by imputed methods becomes β^{-1}. Higher expected return means lower β which lowers the marginal benefit of an additional unit of capital. This means a lower investment. Thus the same model can be use to interpret why the two proxies generate opposite results.

The conceptual difference between ordinary stock-return-based asset pricing and imputed asset pricing models has potential importance beyond the corporate investment context. There is increasing use of imputation based methods in the literature. Recent examples include Chava and Purnanandam (2010), Hou et al. (2010), Pastor et al. (2008), Hail and Leuz (2009), Wu and Zhang (2011), among others.

Ever since Fazzari et al. (1988), financial constraints have played a major role in the investment regressions literature. Accordingly it is natural to study how they relate to the WACC. Perhaps the most widely used measures of financial constraints are the KZ index of Lamont et al. (2001), the WW Index of Whited and Wu (2006), and the SA Index of Hadlock and Pierce (2010). There is a fair bit of controversy over how best to measure financial constraints. For instance, Hadlock and Pierce (2010) is particularly critical of the KZ index. On the other hand the KZ index continues to be used by leading finance scholars such as Hong et al. (2011).

We find that the KZ index is approximately independent of the WACC. The WW and SA indices are both monotonic increasing in WACC. The "more constrained firms" in the WW and SA sense, have a higher WACC. In theory a financial constraint is a quantity constraint, while a cost of capital is measure a required rate of return. Conceptually these are rather different. However, empirically financial constraints and the cost of capital are close cousins.

We are not aware of any previous attempts to systematically study the impact of the WACC on corporate investment. Indeed there are surprisingly few studies of the WACC altogether. Kaplan and Ruback (1995) study a sample of high leverage transactions between 1983 and 1989 for which they have cost of capital and expected cash flow information. Gilson et al. (2000) study a sample of firms in bankruptcy reorganization. In both of these studies they have published cash flow forecasts. In both studies the discounted cash flow analysis performs rather well.

There have been a couple of papers that study the impact of the debt market on investment. Philippon (2009) links bond prices to unobservable marginal Q. To do this he calibrates a dynamic investment model. He finds that the bond price implied Q performs much better than the traditional equity based Q using aggregate investment data. Thus he uses the bond market as an alternative source to infer Q. The current paper, in the spirit of the textbook WACC, regards the bond market and the equity market as two sources of financing that need to be weighted, rather than using one as a proxy for the other. Philippon (2009) studies the cost of debt only. This distinction proves to be important since we show that the effect of expected return of debt on investment is not simply a better proxy for the expected return on equity. Conceptually this emerges clearly from the analysis of Liu et al. (2009).

The study by Gilchrist and Zakrajsek (2007) examines the empirical impact of cost of debt on firm investment, using firm credit spreads as a proxy. They run the investment regressions and find that investment is negatively related with the cost of debt. By studying WACC, our paper is obliged to consider issues that do not arise in Gilchrist and Zakrajsek (2007) or Philippon (2009). In particular we found that the cost of equity is very important to computing the WACC, while Philippon (2009) and Gilchrist and

Zakrajsek (2007) do not consider the impact of cost of equity on investment, which is one of the main focus and contribution of this paper.

Using a Factor Augmented VAR, Gilchrist et al. (2009) study the impact of shocks to both the stock market and to the bond market. However they focus on several macroeconomic series such as employment and industrial production rather than corporate investment. Similar in spirit to Philippon (2009), they find that the credit market data seems to have better predictive ability than does the equity market data for subsequent macroeconomic performance. However, they do not explore investment directly, nor do they approach the equity market data in a manner that corresponds to the WACC. As a result they do not address the issues that are the main focus of this paper.

A somewhat more distantly related study is Fama and French (1999). They carry out an ex post analysis of the cost of capital and the return on investment. Since the analysis is ex post they are able to side step the problems in computing the WACC and free cash flows.

It is well known that the CAPM has problems fully accounting for stock returns. Da et al. (2012) argue that the CAPM is more useful at the project level than at the firm valuation level. This can happen if firms get options to invest where the underlying projects are themselves well accounted for by the CAPM.

The rest of the paper proceeds as follows. Section I describes the practical issues that arise in computing the WACC and provides descriptive statistics. Section II shows the effect of introducing versions of the WACC into investment regressions. Section III uses a standard model to provide a theoretical interpretation of the evidence. Section IV shows the relationship between the WACC and several popular financial constraint measures. The conclusion is in Section V.

I. Computing WACC

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

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

Computation of r_{wacc} thus requires measuring r_E, r_D, E, D, V, and τ_c. For each of these many seemingly plausible alternative proxies are available. Not surprisingly, while some choices are more common than others, various practitioners report using a range of alternative proxies in actual practice.

The data sources and data cleaning are described in the first Appendix. The data is from standard sources, and we winsorize the data in each 1% tail. Using the Fama and French (1997) industry definitions, we drop firms in utilities, banking, insurance, real estate, trading, and with a missing industry code.

There are important systematic differences among the estimates. One group of estimates we call stock-return models. These are the familiar CAPM, the Fama and French (1993) three-factor model, and the Carhart (1997) model that adds a momentum factor to the Fama-French model. The other group we refer to as the imputed cost of equity approach. These are the Gordon Growth Model and the Gebhardt et al. (2001) or GLS model.[5]

The impact of these two groups on WACC stems directly from the cost of equity itself. Within each grouping the other factors tend to make much less difference. As a result, for illustrative purposes we tend to focus on the CAPM (using a 10 year government

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[5] The classical imputation method is the Gordon growth model, as taught in textbooks such as Benninga (2008). An increasingly popular version is based on residual income accounting as proposed by Gebhardt et al. (2001) (GLS) and further studied by Nekrasov and Shroff (2009), Hou et al. (2010), Lee et al. (2010) and Lewellen (2010).

bond rate as the risk-free rate) to represent the first group. We tend to use the Gordon Growth Model to represent the second group.

A. Descriptive Statistics

Table 1 provides descriptive statistics for the main variables of interest. The mean firm has an investment-to-capital ratio of 0.168, but the median is just 0.118. The distribution is not symmetric. Figure 1 plots the median of the investment ratio along with the 5% and 95% bands over time. These are constructed for any given year by considering the distribution for the firms that are active in that year.

Figure 1 shows that the median investment ratio is quite stable over time. However the 95% band fluctuates a great deal. The early 1980s and the late 1990s have extremely high values for the 95% band. The firms that were investing heavily, were really investing very heavily at these times, even though the median firms were not affected all that much.

The cost of equity is rather sensitive to how it is measured. As can be seen in Table 1, the stock-return based versions have values of about 0.15 while the imputed versions tend to have values of about 0.10. In other words the stock-return models seem to generate a cost of equity that is about 50% higher than that implied by the imputed methods. This is because the 10-year treasury yield is high, contributing the high cost of equity from stock-return models.

Not only do the stock-return pricing and imputed versions of the WACC differ on average, they also have different dynamics. Figure 2 plots version of the WACC computed using the CAPM and the GGM, along with the observed return on the market and the return on 10 year government bonds. The upper panel plots the CAPM version of the WACC. The lower panel plots the GGM version of the WACC.

Figure 2 shows the well-known fact that stock returns are much more volatile than the return on long dated government bonds. Since the WACC is a weighted sum of these (albeit with time varying weights) it is not too surprising that the WACC is much less volatile than the stock market. This is true for both versions of the WACC.

In Figure 2 the cost of capital for the median firm was gradually falling from 1980 to 2000 under both CAPM and GGM versions of WACC. Despite some similarities, the dynamics of the two versions of the WACC are fairly different over some years. During the mid 1970s and also during the crisis of 2007-2009 the GGM version of the WACC had a much larger increase that the CAPM version of the WACC. Looking back at Figure 1 we can see that these were periods during which the upper 95% band of the investment ratio was lower than it had been previously. The impact on the median firm is not quite as clear cut.

Figure 3 illustrates that the cross-section differences in the WACC are large. As observed in Figure 1, investment by the median firm is quite stable over time. In Figure 3 we see that the median firm's cost of capital is also relatively stable over time. The median CAPM version tends to stay between 0.1 and 0.2. The median GGM version tends to stay between 0.05 and 0.15. However the 95% bound is much more variable. Under the CAPM it goes above 0.25 in the mid 2000s. Under the GGM it shoots up well above 0.35 during the 2007 financial crisis.

Table 2 computes statistics used in the computations of WACC. In each case one factor is fixed and then each of the other factors is changed over the full set of other proxies under consideration. For instance for $r_{E,CAPM,10Y}$ we fix the cost of equity (which is computed using CAPM and 10-year treasury rate as the risk free rate), and report summary statistics of the WACC that use the same certain factor ($r_{E,CAPM,10Y}$). To get a sense of how much impact these other factors have on the corresponding WACC we compute statistics across these methods for each firm in each year. Notice that this gives us a sample size that is a fair bit bigger than the number of firm-years, because it reflects these multiple measuring methods.

In Table 2 we again see that the stock-return based versions of the WACC are routinely much higher than the imputed versions. This demonstrates that the distinction is not just some accident of how the other proxies line up. The second important point in Table 2 is that the proxies used for the tax rate, the leverage rate, and the cost of debt make relatively small differences on average.

To measure the cost of debt r_D it is common to use the actual yield on the debt the firm is currently carrying. This method is particularly simple to compute and to interpret. However, the method is frequently criticized since it does not necessarily reflect the current debt market conditions facing the firm. The cost of debt computed this way will generally appear to be much smoother than the actual debt market rates. As an alternative we compute the average yield of the firm's incremental debt issued during the year. This details of this calculation are described in the Appendix. This method is still an approximation, but it should more closely reflect current market conditions in the given year. As shown in Table 1, the average cost of debt (0.108) is about half as big as the incremental cost of debt (0.233). Since the cost of debt gets a lower weighting in the WACC, this difference proved less crucial than the difference in how the return on equity is measured.

There is no consensus on how to correctly measure a firm's target leverage. We examine the firm's actual book leverage, actual market leverage, a weighted sum of market and industry median, and the leverage target using the model of Frank and Goyal (2009). The leverage ratios are generally about 0.2 or 0.25.

For taxation we consider the top statutory federal corporate income tax rate. This 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. Thus we also consider the average income tax rate paid by a firm. This will be a good measure if the firm's tax rate is very persistent from year to year. More sophisticated measures are available for recent years from the study by Graham and Mills (2008). They include more of the tax code structure. We examine the impact of two measures considered in that study. The first is the simulated tax which covers the period from 1980 to 2010. The problem is that it does not cover all the firms. The second measure is the OLS predicted tax, which covers a large portion of our sample. The alternative tax code measures do make some difference, primarily for the CAPM and Fama-French cost of equity approaches.

Table 3 provides correlations among several of the factors. Column 1 shows that the cost of equity from the asset pricing models is positively correlated with investment, while the imputed measures are negatively correlated with investment. This is a feature of the data that shows up in various settings. Understanding this difference is important. As expected, Q is strongly positively correlated with investment. EBITDA is also positively correlated with investment although less strongly.

B. Investment and WACC

Table IV shows what happens when we examine the investment of firms sorted into quintiles by r_{wacc}. To permit an impact of corporate cash flows in addition to sorting by r_{wacc} we also sort by either EBITDA/K (top two panels), or Q (bottom two panels). Since there are 440 measures of WACC we cannot report all the results. Within each cell the median value of I/K is computed. Differences in the mean values of the high and low quintiles are also computed, along with statistical tests of the no difference hypothesis.

$WACC_{CAPM,10Y}$ uses the proxies that are fairly typical among the practitioners surveyed by AFP (2011), and it is also quite close to typical textbook discussions. This version uses market leverage and takes a 10 year government bond as the risk-free rate.

For this version, high WACC is associated with high I/K. This is true when the sorting is only based on WACC. This is also true for two way sorts. In the top panel the second sort is on EBITDA/K. In the third panel the second sort is on Q. In each case high $WACC_{CAPM,10Y}$ is associated with high I/K.

$WACC_{GGM,HDZ5}$ is a typical imputed version of the WACC that is based on the Gordon Growth Model. The expectations are imputed using the method of Hou et al. (2010). This method seems to perform better than using analyst forecasts, and it also allows for a larger sample size than IBES would permit.

For this version, high WACC is associated with low I/K. This is true in the one way sorts, and in the two way sorts. The two way sorts match what we did for $WACC_{CAPM,10Y}$. In each case, when we use $WACC_{GGM,HDZ5}$, high WACC is associated with low I/K.

This evidence shows that the association of WACC and I/K is sensitive to the way in which we compute the WACC. This evidence also shows that Q does not appear to serve as a sufficient statistic that subsumes the impact of $WACC$ on investment. However sorting is fairly blunt. It is common to examine these relationships using investment regressions.

II. Investment Regressions

The usual investment regression can be written as,

$$I_{i,t}/K_{i,t} = \alpha + \beta_Q Q_{i,t-1} + \beta_{EBITDA} EBITDA_{i,t}/K_{i,t} + \sum_i Ind_i + \sum_t year_t + \varepsilon_{i,t}. \quad (2)$$

This empirical specification stems from the original work of Fazzari et al. (1988), and it has been the source of some controversy ever since. It can be justified under stringent structural assumptions. It can be criticized under other structural assumptions such as in Erickson and Whited (2000), or Gomes (2001). Despite this ongoing controversy, the model and its very close cousins, remain in wide use as a useful benchmark, see for instance Hadlock and Pierce (2010), Gatchev et al. (2010), Chen and Chen (2012), or Gala and Gomes (2012).

The fixed effects are intended to pickup the impact of otherwise omitted factors that are either industry-specific or year-specific constants. In this model $\beta_Q > 0$, $\beta_{EBITDA} = 0$ is the usual prediction. The usual estimates depend on the sample of firms and the time period to some degree. It used to be common to find $\beta_{EBITDA} > 0$. However in the past decade or two the effect has weakened sharply according to Chen and Chen (2012).

In our reported estimating equation in Table V we have followed common practice of including industry and year fixed effects. This is common, but not uniform. The motivation is to remove the impact of otherwise omitted common factors. However, it is also possible that the industry fixed effects could actually serve to dummy out the effect of the financial constraints. To avoid this problem we have run all of our tests four ways: with no fixed effects, with only year fixed effects, with only industry fixed effects, and with both industry and year fixed effects. We also replaced industry fixed effects with firm fixed effects. The main results are not sensitive to which of these we use.

There are several approaches to computing regressions that are popular in finance. In empirical asset pricing, the Fama-MacBeth method is popular. In corporate finance, Petersen (2009) suggests that standard errors be clustered at both firm and year level. A fixed effect model assumes a permanent and constant firm or year fix effect. Two-way clustering is more robust. Some scholars are particularly concerned about empirical robustness. We find all of these perspective compelling on their own terms. Rather than picking a winner, and we ran all of our result for all WACC measures using each of these methods. All methods generate very similar results. We report results for clustered standard errors using the Stata code provided by Petersen (2009).

In the first column of Table V, the traditional CAPM is used as the cost of equity. In the second column the Fama French factors plus momentum (FF4) is used as the cost of equity. In column three a Gordon Growth model is used. In the fourth column the GLS version of implied cost of capital is used. The first four columns use the current versions of the WACC. Columns 5 to 8 use the corresponding lagged values of WACC.

In all columns of Table V, both Q and EBITDA/K are empirically significant with positive coefficients. Consistent with Chen and Chen (2012) we find that the T-statistic on Q is bigger than that on EBITDA/K. This is true whether we use contemporaneous or lagged values of WACC.

Table V shows that the choice of cost of equity measure really matters for the sign of the coefficient on WACC. Both CAPM and FF4 versions of the WACC have a positive and statistically significant coefficient. Most GGM and GLS measures have a negative and statistically significant sign. The one exception is the lagged GLS. For that case the coefficient was not statistically significant at conventional levels.

Table V shows that the evidence found in the sorting carries over to investment regressions. The effects are not disrupted by firm and year fixed effects. The impacts are roughly similar in magnitude when we use contemporaneous WACC or when we use lagged WACC. So the precise timing convention does not appear to be too critical.

In Table V we use EBITDA/K as a measure of cash flow. This is common in the empirical literature. However the theoretical basis has been criticized. Formal models often suggest the use of Sales/K instead (e.g. Gomes and Gala (2012)). This has a more natural state variable interpretation. Since both EBITDA/K and Sales/K are can be found in the literature in Table VI we replace EBITDA/K with Sales/K.

The change from EBITDA/K to Sales/K does not affect the impact of WACC. Once again we observe that the stock-return model versions of WACC have positive coefficients while the imputed versions have negative coefficients. The insignificant coefficient on the GLS version of WACC is now negative and statistically significant. Thus the WACC results more closely mirror the sorting results, when we use Sales/K instead of EBITDA/K. Table VI also shows that the Sales/K variable seems to be a somewhat more effective regressor than is EBITDA/K. Since Sales comes more naturally out of a neoclassical model, we find this to be some interest in its own right.

A. Across the Decades

Chen and Chen (2012) document that cash flow has become less important relative to Q in recent decades. Could a similar change harm our inferences about the role of WACC? To answer this question, Table VII provides investment regressions by decade for two versions of WACC. We compare the results for EBITDA/K to the results for Sales/K.

The results are striking. Consistent with Chen and Chen (2012) we find the effect of EBITDA/K diminishes particularly in the last decade. Q remains positive and statistically significant over time. The results for Sales/K are quite different from EBITDA/K. Sales/K remain statistically significant during the most recent decade.

More importantly for our purposes, in Table VII the WACC coefficients do fluctuate a bit over the decades. The $WACC_{CAPM,10Y}$ version is statistically significant during the 1960s and the 1990s. However, it is not significant during the 1980s and the 2000s. The $WACC_{GGM,HDZ5}$ is negative and statistically significant in all decades.

The difference between $WACC_{CAPM,10Y}$ and $WACC_{GGM,HDZ5}$ across the decades seems curious. To help trace its source empirically we next decompose the WACC into component parts and examine their individual impacts.

B. Decomposition of WACC

In order to construct the WACC it is necessary to make choices about proxy variables for the components. We already know that the cost of equity choice matters. In Table VIII we provide all 440 coefficients on WACC in an investment regression. This permits the reader to get a sense of how much variation is found.

In Table VIII the negative coefficient on GGM and GLS models with HDZ estimates for earnings estimates is very clear. It is almost always observed and is statistically significant, no matter which proxies are used for the rest of the WACC. The coefficients on the stock-return based versions of the WACC are much less reliable.

The next step is to examine the impacts of the individual components of the WACC in investment regressions. Table X provides a decomposition that uses the top Federal corporate income tax rate as the measure of the tax rate. Table XI replaces the statutory tax rate with a simulated tax rate.

In the decompositions, $r_{D,AV}$ routinely has a negative sign. The higher the cost of debt, the lower the investment. In the stock return versions, the cost of equity always has a positive sign. In the imputed cost versions, the cost of equity routinely has a negative sign.

The top marginal tax rate always has a positive sign in Table X. This makes sense within the Liu et al. (2009) model way of thinking. The corporate tax rate is progressive, so that a more profitable firm will tend to face a higher tax and also to do more investing. Another aspect was pointed out by an anonymous referee. The statutory tax rates have been falling for a number of decades. Thus the secular trend is likely responsible for part of the tax impact. We believe that this is part of the explanation for the time dimension. However, for the cross section the impact of the progressive corporate tax code seems important. In Table XI we see that the impact of the tax variable differs between the stock return based measures and the imputed measures.

The result in Tables X and XI are useful for empirically tracing back the difference between imputed and stock return versions of the WACC. The imputed versions of WACC are a weighted sum of negative numbers, and so they are negative. The impacts of stock return based WACC depend on the relative strength between a positive value of cost of equity and a negative value of cost of debt.

The empirically accounting for the difference is a useful step. It identifies where the difference is coming from. However, it cannot explain why. To explain why requires a theory or a model. Accordingly we turn next to showing how this evidence can be interpreted in terms of the model in Liu et al. (2009).

III. Why are Stock Return and Imputed Versions of WACC So Different?

This section shows how the model of Liu et al. (2009) can be used to interpret the difference between the stock-return versions of WACC and the imputed versions of WACC. The stock-return WACC results follow directly from the comparative statics. The imputed WACC results can be understood as a result of a restriction on the model that is needed to carry out imputation. For simplicity of notation we omit the firm subscripts, but otherwise the notation follows Liu et al. (2009):

E_t is the expectation based on the information available at period t,

M_{t+s} is the pricing kernel that applies to period $t+s$ cash when valued at period t,

D_t is dividend at the end of period t,

Y_t is firm sales at the beginning of period t,

V_t is the value of the firm at the end of period t,

P_t is the ex-dividend equity value at the end of period t $(V_t - D_t)$,

I_t is investment in period t,

K_t is the capital stock at the beginning of period t,

B_t is the borrowing that is due to be repaid in period t,

r_t^B is the gross debt cost (interest plus principal) before tax per unit of principle debt,

r_t^{Ba} is the after-tax bond return, $((r_t^B - 1)(1-\tau_t)+1)$,

r_t^I is the return on investment in period t,

r_t^S is the gross stock return $(\frac{P_t+D_t}{P_{t-1}})$ at the end of period t,

w_t is leverage at the end of period t, $(w_t = \frac{B_{t+1}}{V_t - D_t + B_{t+1}})$,

$\Pi(K_t, X_t)$ is the firm production,

$\Phi(I_t, K_t)$ is the adjustment cost of investment,

δ_t is the depreciation rate,

ROE_t is the return on equity in period t,

and the tax rate in period t is τ_t.

As depicted in Figure 4, at the beginning of a period t the firm inherits a capital stock K_t and a debt level B_t, from the previous period. Once the period starts a random shock X_t is realized. These are the three state variables in the model. The realization of the shock follows some stochastic process such as an $AR(1)$ process. Because we are only computing comparative statics, we do not need to specify the exact form of the shock process. Liu et al. (2009) assume that this shock is firm-specific in order to get cross-sectional differences among the firms.

After observing X_t, the firm simultaneously pays the debt that is due ($[(r_t^B - 1)(1 - \tau_t) + 1]B_t$), decides on current borrowing (B_{t+1}) and current investment I_t. The choice of investment determines the capital stock K_{t+1}. The current borrowing implies that next period the firm will have to pay ($r_{t+1}^{Ba} B_{t+1}$). This choices allow the calculation of a number of features of the model such as V_t, D_t, w_t and r_t^S.

It is assumed that the technology $\Pi(K_t, X_t)$ is constant return to scale, so that $\Pi(K_t, X_t) = \frac{\partial \Pi(K_t, X_t)}{\partial K_t} K_t$, and so $\frac{\partial \Pi(K_t, X_t)}{\partial K_t} = \alpha \frac{Y_t}{K_t}$ where α is capital's share. There are adjustment costs that take the form $\Phi(I_t, K_t) = \frac{1}{2} a (\frac{I_t}{K_t})^2 K_t$ in which $a > 0$.

The dividend at date t is a function of (X_t, K_t, B_t) and is given by,

$$D_t = (1 - \tau_t)[\Pi(K_t, X_t) - \Phi(I_t, K_t)] - [(r_t^B - 1)(1 - \tau_t) + 1]B_t - I_t + B_{t+1} + \tau_t \delta_t K_t \quad (3)$$

The total firm value is from,

$$V_t = \max_{I_t, K_{t+1}, B_{t+1}} D_t + E_t(M_{t+1} V_{t+1}) \quad (4)$$

with capital evolution process $I_t = K_{t+1} - K_t(1 - \delta_t)$.

The key result that we take from Liu et al. (2009) is their Proposition 1 which says,

$$\begin{aligned} r_t^I &= \frac{\left\{(1-\tau_t)\left[\alpha\frac{Y_t}{K_t} + \frac{1}{2}a(\frac{I_t}{K_t})^2\right] + \tau_t\delta_t + (1-\delta_t)\left[1 + (1-\tau_t)a\frac{I_t}{K_t}\right]\right\}}{1 + (1-\tau_{t-1})a\frac{I_{t-1}}{K_{t-1}}} \qquad (5) \\ &= w_{t-1}r_t^{Ba} + (1-w_{t-1})r_t^S. \qquad (6) \end{aligned}$$

The right hand side of equation 6 is the WACC.

In the model the return on investment is the WACC. Thus things that alter the return on investment have implications for the WACC. However, the WACC is **not** a state variable itself. The state variables are the inherited physical capital and debt along with the current period shock. Thus exogenous parameter changes that alter the historical values of the state variables have corresponding effects on the WACC. In a sense, the WACC can be viewed as an effect rather than a cause of investment choices within the model.

A. Comparative Statics

We want to understand how investment is related to stock returns within the model. In the textbooks we might expect investment to be directly related to r_t^{Ba}. However, in the model r_t^{Ba} is due on debt that was inherited from the past, i.e. before the current period shock. Current investment, I_t, is determined after the current period shock is realized. In other words, the state variables for I_t are X_t, K_t, B_t, while the state variables for r_t^{Ba} are $X_{t-1}, K_{t-1}, B_{t-1}$ (as shown by Gomes and Schmid (2010)).

The key comparative static is that the realized stock return is increasing in investment. This derivation is included in the Appendix. The intuition is that if the shock is favorable then stock returns are positive, and extra investment in reaction to the shock also makes sense. Thus we should see stock returns positively related to investment.

This provides an explanation for the empirical results that we obtained on stock-return based versions of the WACC. It is important to realize that the causal link is radically different from the standard textbook formulation of the WACC. In the textbooks WACC is being treated as parametric. In the model WACC is an endogenous construct, not a state variable.

B. Imputed Cost of Capital

In the above derivation the pricing kernel is implicitly derived from an investor optimization problem in which there is an investor with a utility function $u(c)$ where c is the investor consumption. Investor maximization gives the relevant state prices. The pricing kernel is specified by $M_{t+1} = \beta \frac{u'(c_{t+1})}{u'(c_t)}$ where β is time discount or subjective discount factor.

How does this relate to the imputed versions of the WACC? To carry out the imputation it is normal to calculate some time-averages.

In a 5 period version of the Gordon Growth Model (GGM) it is postulated that

$$P_t = \sum_{i=1}^{4} \frac{D_{t+i}}{(r^s)^i} + \frac{D_{t+5}}{(1-r^s)(r^s)^4}. \tag{7}$$

In the Residual Income Model (GLS) it is postulated that

$$P_t = B_t + \sum_{i=1}^{11} \frac{E_t[(ROE_{t+i} - r_e) \times B_{t+i-1}]}{(r^s)^i} + \frac{E_t[(ROE_{t+12} - r_e) \times B_{t+11}]}{r^s(r^s)^{11}}. \tag{8}$$

In each case r^s is being treated as the unknown of the calculation. It is standard to **assume** that the same expected return r^s applies in each of the periods. This is in sharp contrast to the normal assumption of time varying returns.

How can the return be constant across dates within the model? That can happen if the world is stationary and deterministic. It can also happen if the investor has linear preferences.

If the investor has linear preferences then $\frac{u'(c_{t+1})}{u'(c_t)} = 1$. The realized stock return from period t to $t+1$ (at the end of time $t+1$) becomes $r^s_{t+1} = \frac{V_{t+1}}{\beta E_t(V_{t+1})}$. With linear investor preferences,

$$E_t(r^s_{t+1}) = \frac{E_t(V_{t+1})}{E_t(\beta V_{t+1})} = \frac{1}{\beta} \tag{9}$$

Thus for the imputed cost of equity models, in effect the cost of equity is just $\frac{1}{\beta}$.

It is easy to see that the high expect return (and low β), are associated with a low marginal benefit of an additional unit of capital. This in turn will be reflected in a low value of Q, and a low level of investment. Thus the restrictions imposed by the imputed method implies that investment should be negatively related with the imputed versions of the cost of equity.

Another way to formalize this argument is to take the first order condition with respect to I_t,

$$1+(1-\tau_t)a\frac{I_t}{K_t} = E_t\{\sum_{\tau=t+1}^{\infty} \beta^{\tau-t}(1-\delta_\tau)^{\tau-t-1}\left[(1-\tau_\tau)[\Pi_K(K_\tau, X_\tau) - \Phi_K(I_\tau, K_\tau)] + \tau_\tau\delta_\tau\right]\} \tag{10}$$

It is clear that low β (high cost of equity) has low investment.

Thus the process of imputation as normally carried out is imposing intertemporal structure on the return on equity. In particular it is assumed that the return on equity is constant across years. When that is done in a model the cost of equity becomes the inverse of the discount term. If the future marginal benefit is less, the firm invests less.

IV. Financial Constraints and the WACC

Following Fazzari et al. (1988) it is common to introduce financial constraints into investment regressions. Firms are sorted into those that are "financially constrained" and those that are not. Generally it is reported that "financially constrained firms" exhibit greater sensitivity of investment to cash flow than do financially unconstrained firms even though Q has been included as a regressor. Several different indices of financial constraints are in use. The KZ index is from Lamont et al. (2001). The WW index is from Whited and Wu (2006). The SA index is from Hadlock and Pierce (2010). Chen and Chen (2012) finds that cash flow effects in investment regressions have diminished considerably over time, and are no longer statistically significant using recent data.

From the perspective of WACC the popular indices are problematic. They are composed of several elements that are basic to the WACC. The KZ index uses cash flow, Q, leverage, dividends/K, and cash/K. The WW index uses cash flow, dividend dummy, leverage, size, industry sales growth, firm sales growth. The SA index uses size and age. Firm size is related to the leverage choices, as well as to the stock returns.

Consider the KZ index from the standard WACC perspective. Cash flow and Q are both plausible proxies for expected free cash flows. Leverage is a direct element of the WACC. According to Frank and Goyal (2009) dividends are a reliable predictor of leverage. Cash may also belong in the leverage ratio calculation as an adjustment as well. Thus the elements of the KZ index belong in the standard model of WACC, despite the fact that the WACC model assumes no financial constraints.

The WW index components have similar issues. Cash flow proxies for expected free cash flow. The dividend dummy is a known predictor of leverage. Leverage is a component of the WACC calculation. Size is another known predictor of leverage (Frank and Goyal, 2009). Both industry and firm sales growth seem to be very naturally viewed as proxies for a firm's expected future free cash flows.

The SA index consists of size and age both in the levels and squared. Firm size is an established predictor of leverage. Firm age has been considered as a predictor of leverage as well, although Frank and Goyal (2009) do not find it to be a reliable predictor in a model that already includes the other factors.

Table XII sorts firms into quintiles using each of the suggested indices. The results are stark. The WACC is approximately the same for all KZ index quintiles. The WACC is increasing as the WW index increases. WACC is also increasing as the SA index increases.

Recall that a number of papers such as Hadlock and Pierce (2010) have been very critical of the KZ index, and its relationship to actual financial constraints.[6] Thus it is the WW and SA indices that may deserve more attention as measures of financial constraints. Since both of these are positively related to the WACC, it seems that financial constraints and cost of capital are related measures. This is of interest since WACC considerations can arise in markets that are not subject to finance frictions in the usual sense of the term.

V. Conclusion

For more than a generation, business students have been taught to evaluate corporate investments using a standard model. They forecast free cash flows and then discount the cash flows using the weighted average cost of capital (WACC). The required return on equity in the WACC is computed using the CAPM. If the resulting net present value is positive, the investment is worthwhile and otherwise it is not worthwhile. In surveys, senior managers – many of whom have business degrees – report using the WACC when making investment decisions. However, the empirical literature on corporate investment

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[6] In the words of an anonymous referee: “By now many many authors have documented that the KZ index is a very bad measure of finance constraints.”

has ignored the WACC in favor of tests of Tobin's Q theory of investment – a theory that is largely ignored in the teaching of business students.

This paper has studied the relationship between the two methods. Since we have already summarized the findings in the introduction, we close with two open problems suggested by our results.

The volatility of the stock market and the volatility of investment are directly related in the theoretical model. In reality of course, the stock market is much more volatile than investment. It would be interesting to study the extent to which investment lags and time-to-build considerations, or other factors, can help explain this difference. In light of Bloom (2009), it may be important to distinguish large shocks from more routine shocks.

We have shown that the WACC and two popular financial constraint indices are closely connected empirically. Yet in theory they are quite different. In the textbook interpretation, the WACC is suppose to reflect opportunity cost while financial constraints are supposed to reflect quantity constraints. It would be interesting to find a way to empirically distinguish these theoretically distinct concepts.

VI. Appendix: Data Source and Variable Definitions

The firm level data is from the Compustat/CRSP merged data file (CCMD). The sample period is from 1960 to 2010. We drop foreign companies (FIC code = USA), and the companies with a SIC code that is between 4900 and 4999, between 6000 and 6999, or greater 9000, as they are regulated, financial or public service firms. To make sure the results are not driven by small firms, we drop the firms with total asset below 10 million dollars (inflation adjusted in year 2004 dollars). The AFP (2011) report that the typical firm uses the following proxies: leverage is a book debt to equity ratio, cost of equity is the CAPM estimated from monthly data over a 5-year period, cost of debt is interest cost on outstanding debt, the tax rate is the company's own effective tax rate, the risk free rate is the 10-year Treasure bill rate, the equity risk premium is about 5% or 6%. All variables are winsorized at 1% level each tail every year

A. Cost of Debt Proxies

By far the most common proxy for the cost of debt is to take an historical ratio of the interest payments to the total debt of the firm. In the current version of the paper, we use two proxies. The first is $r_{D,INC}$, which is the marginal cost of debt. It is constructed from CCMD data items: xint (Interest and Related Expense), dlc (Debt in Current Liabilities - Total), dltt (Long-Term Debt - Total), dltr (Long-Term Debt / Reduction) and dltis (Long-Term Debt / Issuance)

$$xint_{t+1} - xint_t = (dltis_{t+1} + dlc_{t+1}) \times r_{D,INC,t+1} - \frac{xint_t}{dltt_t + dlc_t} \times (dltr_{t+1} + dlc_t)$$

The second measure is average cost of debt $r_{D,AV}$:

$$r_{D,AV} = \frac{xint}{dltt + dlc}$$

It is well understood that this is a poor proxy since it is backwards looking. A firm cannot borrow today at the rates that it borrowed in the past. What matters today are the current market conditions. For future work, we will also use the firm's credit rating to impute the rate, and the bond yield from the secondary market.

B. Corporate Tax Rate

There are multiple ways to do this.

1. Actual historical average taxes paid by the firm
2. Historical top marginal tax rate
3. Use actual earnings and the tax code to impute the marginal tax cost
4. Use Graham's model. These are simulated corporate marginal tax rates from 1980 to now.

Here, we use four proxies for corporate tax rate. Tax_{SIM} is the pre-financing marginal tax rate simulated by Graham and Mills (2008).[7] Tax_{OLS} is the OLS regression predicted pre-financing marginal tax rate by Graham and Mills (2008) Table IV. It is constructed by $Tax_{OLS} = 0.135 + 0.601 \times BookSimMTR - 0.028 \times USBookLossDummy - 0.020 \times LowUSETRDummy - 0.008 \times NOLDummy - 0.016 \times BookLossDummy + 0.006 \times ForeignActivityDummy$, Where USBookLossDummy =1 if Compustat Item 272 (or, Item 170 if Item 272 missing) < 0, zero otherwise; LowUSETRDummy = 1 if Item 63/Item 272 (or, Item 16/Item 170 if missing) $<$ 10 percent, zero otherwise; NOLDummy =1 if Item 52 $>$ 0, zero otherwise; BookLossDummy = 1 if nonmissing Item 170 $<$ 0, zero otherwise; ForeignActivityDummy = 1 if |Item 273/Item 170| $>$ 5 percent, zero otherwise; $BookSimMTR = 0.345 - 0.055 \times LowUSETRDummy - 0.016 \times NOLDummy - 0.103 \times BookLossDummy + 0.026 \times ForeignActivityDummy$. Item numbers refer to COMPUSTAT annual data items

Tax_{Top} is top marginal tax rate in the corporation income tax brackets from 1909 to 2010 (http://www.irs.gov/taxstats/article/0,,id=175911,00.html). Tax_{AV} is corporate average tax rate, which is CCMD data item txt/pi, where txt is the total taxes and pi is the pretax income. Set this rate missing if it is negative or larger than 100% before winsorizing

C. Leverage

There are two natural candidate leverage ratios. The first is firm average value. For a given date we can multiply the number of shares by the market value of share at that date to get market value of equity E_t. To get debt value D_t it is common to simply use the book value of debt. The second one is industry median. In the WACC calculation, the leverage ratio should be a long run target. The industry median could be one proxy for this target ratio.

Here we use five versions of leverage ratio (CCMD data items in the brackets). Lev_{BK} is annual realized firm book leverage using book value of debt and book value of the firm. It is the book value of debt, Debt in Current Liabilities(dlc)+Long Term Debt (dltt), over the book value of firm, Total Asset (at). Lev_{MKT} is annual realized firm market leverage using book value of debt and market value of firm. The total firm market value is Item 6 + Item 199×Item 25 - Item 60 -Item 74. Item numbers refer to COMPUSTAT annual data items. $Lev_{MKT,Net}$ is annual realized firm leverage using book value of debt net of cash holding (che), see Rajan and Zingales (1995). Book value of debt net of cash holding=Book value of debt- cash holding (che). Lev_{WT} is $(Lev_{IND}+Lev_{MKT})/2$ where Lev_{IND} is the median leverage using Lev_{MKT} of firms in the same industry each year. Industry definition follows Fama-French 48-industry. $Lev_{MKT,TGT}$ is predicted leverage ratio following Frank and Goyal (2009) Table V column 9.

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[7] Per permission from original authors, it could be downloaded from http://faculty.fuqua.duke.edu/jgraham/taxform.html

D. Cost of Equity Proxies

D.1. Stock Return Based Methods

$r_{E,CAPM,10Y}$ is the cost of equity using CAPM model, $r_{E,CAPM,10Y} = r_f + \beta E(r_M - r_f)$. The risk free rate r_f is 10-year Treasury yield from FRED. To estimate firm β, we run rolling window regressions using previous five years monthly stock returns. The dependent variable is the excess stock return (stock return from CRSP - risk free rate in Fama-French market excess return factor) and the independent variable is the Fama-French market excess return.[8] $E(r_M - r_f)$ is the historical mean of the Fama-French market excess return, i.e. the date t equity premium is the average of Fama-French market excess return from time t to the time 1. $r_{E,FF3,10Y}$ is cost of equity using Fama-French 3-factor model. The calculation is similar to $r_{E,CAPM,10Y}$ but use two additional factors (small-big factor, high-low factor) from French's webpage. $r_{E,FF4,10Y}$ is cost of equity using Fama-French 3-factor model and momentum factor. The calculation is similar to $r_{E,CAPM,10Y}$. The monthly momentum factor is from CRSP. $r_{E,CAPM,1M}$ and $r_{E,FF4,1M}$ are constructed by using 1- month Treasury yield which is used to estimate firm β. All proxies are annualized.

D.2. Imputed Methods

There are two accounting models to calculate the cost of equity. The first is Gordon Growth Model (GGM) and the second is Residual Income Model (GLS). Each model will rely on some earnings forecasts. There are two types of this measure. The first is IBES-based earnings per share forecast. The earnings forecast of IBES ranges from one to five years, and a long term growth rate is also provided for some firms. We use the median of earnings forecast.

Alternatively, we can also use the model predicted earnings. Recently Hou et al. (2010) (HDZ), and Lee et al. (2010) have found a fairly simple model to predict earnings that seems to do rather well, and so we use that as well. Let $EV_{j,t}$ denote the enterprise value of firm j in year t, TA is total assets, DIV is the value of dividends paid, DD is a dummy for paying dividends, $E_{j,t}$ is earnings (before extraordinary items) by firm j in year t, $NegE$ is a dummy for negative earnings, ACC is total accruals divided by total assets. The model is

$$E_{j,t+\Delta t} = \alpha_0 + \alpha_1 EV_{j,t} + \alpha_2 TA_{j,t} + \alpha_3 DIV_{j,t} + \alpha_4 DD_{j,t} + \alpha_5 E_{j,t} + \alpha_6 NegE_{j,t} + \alpha_7 ACC_{j,t} + \varepsilon_{j,t+\Delta t}.$$

Both papers estimate this model using pooled cross-section regressions using a rolling prior ten years of data for each year. For comparability we do the same.Δt ranges from 1 to 5. In Hou et al. (2010), E is net income or earnings before extraordinary items (ib); EV is total asset (at)+market value of equity-book value of equity; DIV: dividend payment(dvt); TA is total asset (at); ACC is change in current assets (act)+ change in debt in current liability(dlc)- change in cash and short term investment(che)-change in current liabilities(lct), then scaled by total asset (at).

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[8] Downloaded from French's webpage: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/ftp/F-F_Research_Data_Factors.zip

Following Lee et al. (2010), $r_{E,GGM,IBES1}$ is from the Gordon Growth Model (GGM) using IBES-based earnings forecast, such that $P_t = \frac{EPS_{t+1}}{r_{E,GGM,IBES1}}$ where P_t is the stock price. $r_{E,GGM,IBES5}$ is from GGM using IBES-based earnings per share forecast. We numerically solve the following equation:

$$P_t = \sum_{i=1}^{4} \frac{DPS_{t+i}}{(1 + r_{E,GGM,IBES5})^i} + \frac{EPS_{t+5}}{r_e(1 + r_{E,GGM,IBES5})^4}$$

with,

$$DPS_{t+1} = EPS_{t+1} \times \kappa$$

where dividend payout ratio: κ follows Hou et al. (2010) and Gebhardt et al. (2001)(GLS): if earnings are positive, κ is the current dividends divided by current earnings; if earnings are negative, κ is the current dividends divided by $0.06 \times total\ assets$.

$r_{E,GLS,IBES}$ is from Residual Income Model (GLS) using IBES-based earnings per share forecast. We follow Gebhardt et al. (2001) and Hou et al. (2010) to solve the following equation:

$$M_t = B_t + \sum_{i=1}^{11} \frac{E_t[(ROE_{t+i} - r_e) \times B_{t+i-1}]}{(1 + r_{E,GLS,IBES})^i} + \frac{E_t[(ROE_{t+12} - r_e) \times B_{t+11}]}{r_{E,GLS,IBES}(1 + r_{E,GLS,IBES})^{11}}$$

where M_t is the market value of equity, B_t is the book value of equity. Book value of equity follows Davis et al. (2000). Particularly, book value of equity=stockholder equity (seq) +balance sheet deferred taxes(txdb)+balance investment tax credit (itcb)-book value of preferred stock; book value of preferred stock=in order: redemption(pstkrv), liquidation(pstkl), or par value(pstk) of preferred stock; if stockholder equity (seq) is not available, then stockholder equity=book value of common equity(ceq)+par value of preferred stock(pstk), or stockholder equity=book value of total assets(at)- book value of total liability (lt).

The book value of equity evolves according to

$$B_{t+i} = B_{t+i-1} + Earning_{t+i}(1 - \kappa)$$

where B_t and κ are defined the same as before, and $Earning_t$ is from IBES.

Return on equity ROE_{t+i} is defined as the following: from year one to year three it is the $\frac{Earning_{t+i}}{B_{t+i-1}}$; through year four to year twelve, it is the interpolated value between ROE_{t+3} and industrial median at time t. Industrial median excludes firms with negative earnings

$r_{E,GGM,HDZ1}$ is the same as $r_{E,GGM,IBES1}$but using the model predicted earnings from HDZ. It is the same for $r_{E,GGM,HDZ5}$ and $r_{E,GLS,HDZ}$.

E. WACC

We have 11 measures on cost of equity, 4 measures on tax rate, 2 measures on cost of debt and 5 measures on leverage ratio. In total, we have 440 different WACCs. The 4 WACCs reported in the paper are constructed by the following way: $wacc_{CAPM,10Y} =$

$r_{E,CAPM,10Y} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$, $wacc_{FF4,10Y} = r_{E,FF4,10Y} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$, $wacc_{GGM,HDZ5} = r_{E,GGM,HDZ5} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$, $wacc_{GLS,HDZ5} = r_{E,GLS,HDZ5} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$.

F. Other variables

The gross capital stock K is Item 7. Q is (Item 6 + Item 199×Item 25 - Item 60 -Item 74)/ Item 6. EBITDA is the sum of Item 14 and 18. Sale is the Item 12. I is the capital expenditure Item 128. Item numbers refer to COMPUSTAT annual data items. Data item 7 is lagged.

G. Financial Constraint

Three popular indices that are used to gauge the extent of financial constraints are used:

1. SA index. Following Hadlock and Pierce (2010), $SA\,index = -0.737 \times Size + 0.043 \times Size^2 - 0.040 \times Age$ where Size is the log of inflation adjusted (to 2004) book assets, and age is the number of years the firm has been on Compustat. In calculating this index, Size is replaced with log($4.5 billion) and age with thirty-seven years if the actual values exceed these thresholds.

2. KZ index. Following Lamont et al. (2001), $KZ\,index = -1.001909 \times [(Item18 + Item14)/Item8] + .2826389 \times Q + 3.139193 \times [(Item9 + Item34)/(Item9 + Item34 + Item216)] - 39.3678 \times [(Item21 + Item19)/Item8] - 1.314759 \times [Item1/Item8]$. Item numbers refer to COMPUSTAT annual data items. Data Item 8 is lagged.

3. WW index. Following Whited and Wu (2006),$WW\,index = 0.091 \times CF - 0.062 \times DIVPOS + 0.021 \times TLTD - 0.044 \times LNTA + 0.102 \times ISG - 0.035 \times SG$ where CF=[(Item 18 + Item 14)/ Item 8]; DIVPOS=1 if Item 127>0; TLTD=[(Item 9+Item 34) / (Item 9+Item 34 + Item 216)] ; LNTA=log(Item6); ISG is the firm's three-digit industry sales growth; SG is the firm's sales growth. Item numbers refer to COMPUSTAT annual data items. Data item 8 is lagged.

VII. Appendix: Comparative Statics

The optimal borrowing amount B_t at the end of time t-1 is determined by this no arbitrage condition

$$B_t = E_{t-1}\left[M_t\left[r_t^B B_t \mathbb{I}_{(V_t>0)} + R_t(1 - \mathbb{I}_{(V_t>0)})\right]\right]$$

where

$$R_t = (1 - \tau_t)\Pi(K_t, X_t) + \tau\delta K_t + \varphi_1(1 - \delta)K_t - \varphi_0$$

is the recovered value when default happens at time t and the indicator function

$$\mathbb{I}_{(V_t>0)} = 1 : if : V_t > 0.$$

This no arbitrage condition says when default happens ($\mathbb{I}_{(V_t>0)} = 0$), the lender gets R_t. When there is no default $\mathbb{I}_{(V_t>0)} = 1$, lender gets $r_t^B B_t$.

Clearly r_t^{Ba} is a function of the state variables X_{t-1}, K_t, B_t. Recall that before the beginning of time t, B_t and K_t are choice variables that are determined at the end of time $t-1$. So K_t, B_t are a function of $X_{t-1}, K_{t-1}, B_{t-1}$. In the end r_t^{Ba} is a function of the state variable $X_{t-1}, K_{t-1}, B_{t-1}$. So the right comparative static are $\frac{\partial \frac{I_{t-1}}{K_{t-1}}}{\partial r_t^{Ba}}$ or $\frac{\partial i_{t-1}}{\partial r_t^{Ba}}$. Both r_t^{Ba} and $\frac{I_{t-1}}{K_{t-1}}$ are simultaneously determined before time t.

The above analysis is essentially in Gomes and Schmid (2010), although we set up the problem so that the state variables are as in Liu et al. (2009).

Investment I_t is directly related to the realized stock return in the same period r_t^S. The state variables for both I_t and V_t are X_t, K_t, B_t. At the end of period t, the realized stock return is $r_t^S = \frac{V_t}{V_{t-1}-D_{t-1}}$. So both I_t and r_t^S are determined after time t. The right comparative statistics is $\frac{\partial \frac{I_t}{K_t}}{\partial r_t^{Ba}}$ or $\frac{\partial i_t}{\partial r_t^S}$.

$\frac{I_t}{K_t} = i_t$ is related with r_t^S, and $\frac{I_{t-1}}{K_{t-1}} = i_{t-1}$ is related with r_t^{Ba}. the right comparative statics should be $\frac{\partial i_{t-1}}{\partial r_t^{Ba}}$, and $\frac{\partial i_t}{\partial r_t^S}$. Write

$$\begin{aligned}\mathcal{F}(*) \quad = \quad & \left\{(1-\tau_t)\left[\alpha\frac{Y_t}{K_t} + \frac{1}{2}a(\frac{I_t}{K_t})^2\right] + \tau_t\delta_t + (1-\delta_t)\left[1+(1-\tau_t)a\frac{I_t}{K_t}\right]\right\} \\ & - \left[1+(1-\tau_{t-1})a\frac{I_{t-1}}{K_{t-1}}\right]\left[w_{t-1}r_t^{Ba} + (1-w_{t-1})r_t^S\right]\end{aligned}$$

From the Implicit Function Theorem, we have

$$\frac{\partial i_{t-1}}{\partial r_t^{Ba}} = -\frac{w_{t-1}\left[1+(1-\tau_{t-1})a\frac{I_{t-1}}{K_{t-1}}\right]}{(1-\tau_{t-1})a\left[w_{t-1}r_t^{Ba} + (1-w_{t-1})r_t^S\right]}.$$

If $w_{t-1}r_t^{Ba} + (1-w_{t-1})r_t^S > 0$ and $1+(1-\tau_{t-1})a\frac{I_{t-1}}{K_{t-1}} > 0$, then $\frac{\partial i_{t-1}}{\partial r_t^{Ba}} < 0$

$$\frac{\partial i_t}{\partial r_t^S} = \frac{\left[1+(1-\tau_{t-1})a\frac{I_{t-1}}{K_{t-1}}\right](1-w_{t-1})}{(1-\tau_t)a\frac{I_t}{K_t} + (1-\delta_t)(1-\tau_t)a}$$

If $1+(1-\tau_{t-1})a\frac{I_{t-1}}{K_{t-1}} > 0$ and $(1-\tau_t)a\frac{I_t}{K_t} + (1-\delta_t)(1-\tau_t)a > 0$, then $\frac{\partial i_t}{\partial r_t^S} > 0$.

In the sample, the investment capital ratio is always positive, so it always satisfies the condition such that $\frac{\partial i_t}{\partial r_t^S} > 0$. So the investment is positively related with stock return.

Figure 1: Investment Ratio

The firm level data is from the Compustat/CRSP merged data file.The sample period is from 1960 to 2010. We drop foreign companies (FIC code = USA), and the companies with a SIC code that is between 4900 and 4999, between 6000 and 6999, or greater 9000, as they are regulated, financial or public service firms. We also drop the firms with total asset below 10 million dollars (inflation adjusted in year 2004 dollars). The gross capital stock K is Item 7. Capital expenditure I is Item 128. Item numbers refer to COMPUSTAT annual data items. Data item 7 is lagged. All variables are winsorized at 1% level each tail every year. The connected line is the cross sectional median of I/K each year. The dash line is the 95 percentile of I/K each year. The dash-dot line represents the 5 percentile of I/K each year.

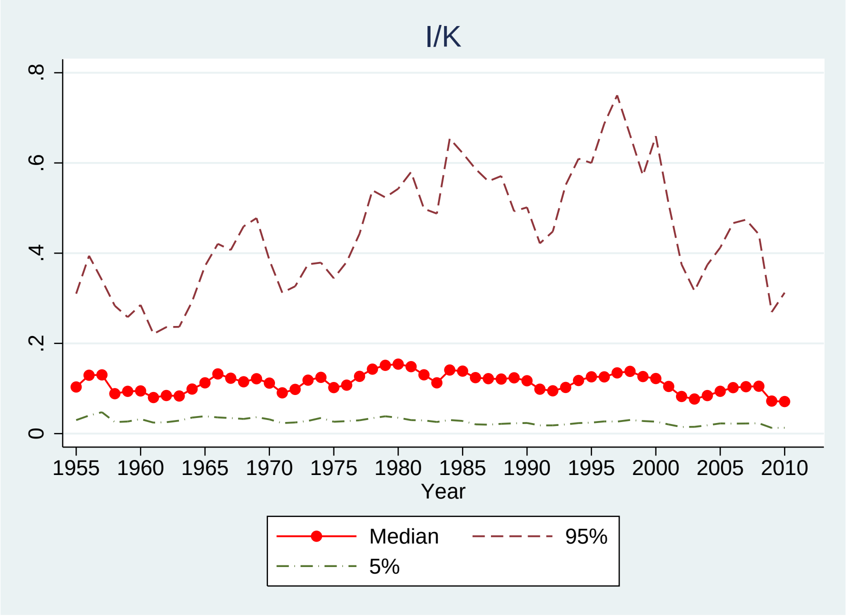
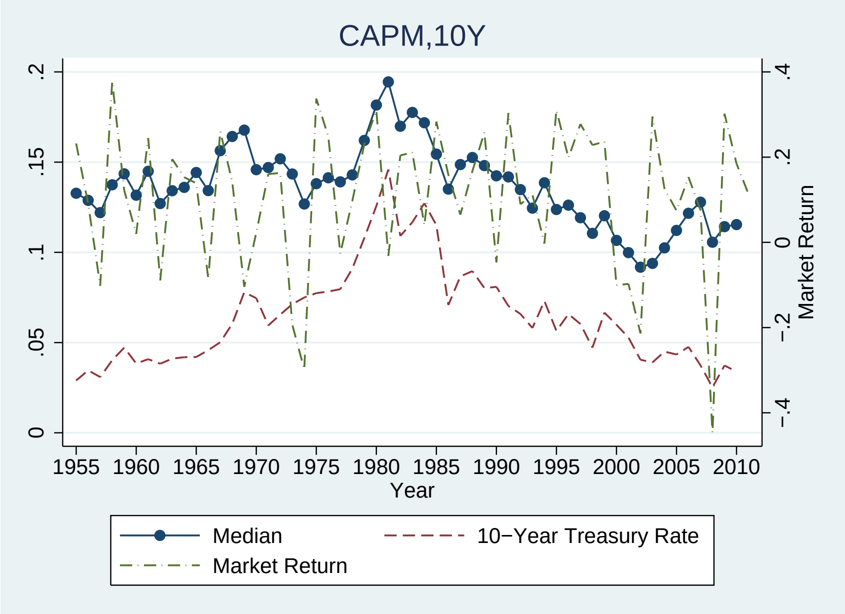


Figure 2: Weighted Average Cost of Capital and Market

The firm level data is from the Compustat/CRSP merged data file.The sample period is from 1960 to 2010. We drop foreign companies (FIC code = USA), and the companies with a SIC code that is between 4900 and 4999, between 6000 and 6999, or greater 9000, as they are regulated, financial or public service firms. We also drop the firms with total asset below 10 million dollars (inflation adjusted in year 2004 dollars). The upper panel shows one version of WACC $wacc_{CAPM,10Y}$, the market return and 10-year Treasury rates over time. $wacc_{CAPM,10Y} = r_{E,CAPM,10Y} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$. $r_{E,CAPM,10Y}$ is the cost of equity from CAPM model; Lev_{WT} is the firm target leverage; $r_{D,AV}$ is the average cost of debt; Tax_{Top} is the top marginal tax rate in the corporation income tax brackets. The variable construction details are in the Appendix. Market return is the annualized average monthly market return in Fama-French market factor. The connected line is the firm cross sectional median of $wacc_{CAPM,10Y}$ each year. The dash line is the 10-Year Treasury Rate. The dash-dot line represents the market return. The lower panel uses another version of WACC $wacc_{GGM,HDZ5}$. $wacc_{GGM,HDZ5} = r_{E,GGM,HDZ5} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$. $r_{E,GGM,HDZ5}$ is the cost of equity using Gordon Growth Model. The construction details are in the Appendix.


CAPM,10Y
0
.05
.1
.15
.2
−.4
−.2
0
.2
.4
Market Return
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Year
Median
10−Year Treasury Rate
Market Return

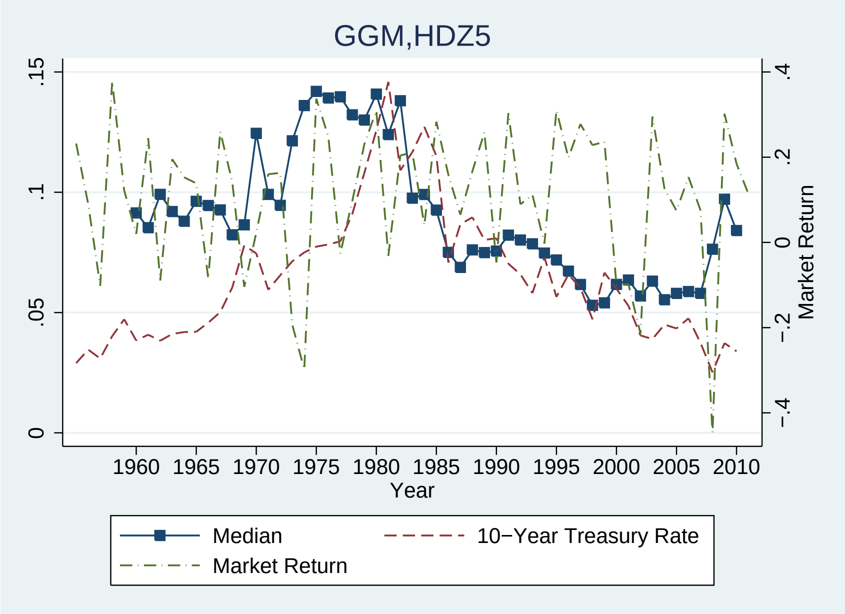
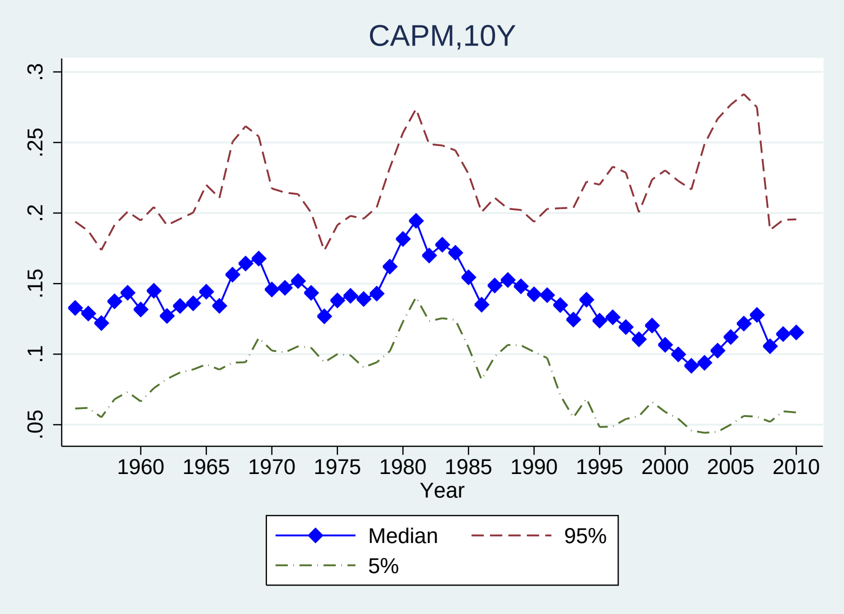
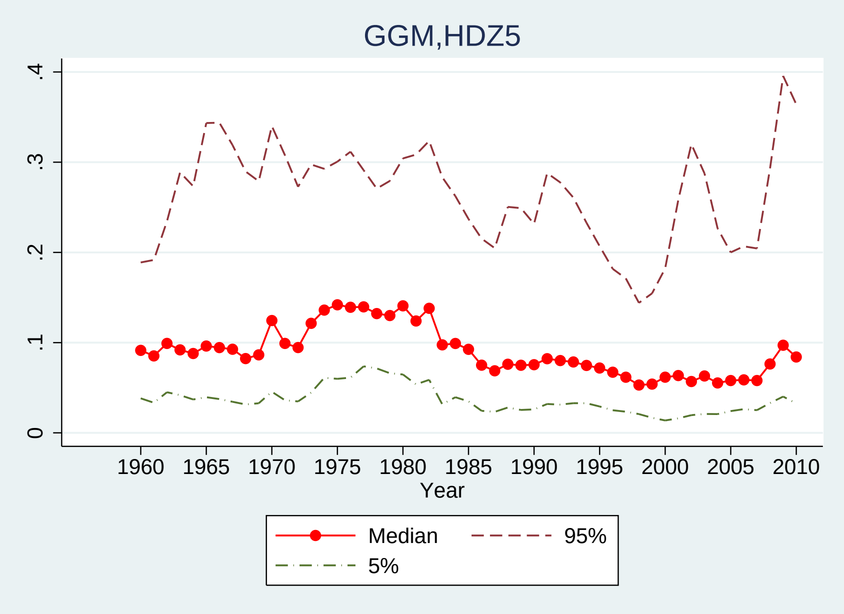

GGM,HDZ5
0
.05
.1
.15
−.4
−.2
0
.2
.4
Market Return
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Year
Median
10−Year Treasury Rate
Market Return

Figure 3: Weighted Average Cost of Capital: Cross Section

The firm level data is from the Compustat/CRSP merged data file.The sample period is from 1960 to 2010. We drop foreign companies (FIC code = USA), and the companies with a SIC code that is between 4900 and 4999, between 6000 and 6999, or greater 9000, as they are regulated, financial or public service firms. We also drop the firms with total asset below 10 million dollars (inflation adjusted in year 2004 dollars). The upper panel plots one version of WACC $wacc_{CAPM,10Y}$. $wacc_{CAPM,10Y} = r_{E,CAPM,10Y} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$. $r_{E,CAPM,10Y}$ is the cost of equity from CAPM model; Lev_{WT} is the firm target leverage; $r_{D,AV}$ is the average cost of debt; Tax_{Top} is the top marginal tax rate in the corporation income tax brackets. The variable construction details are in the Appendix. The connected line is the firm cross sectional median of $wacc_{CAPM,10Y}$ each year. The dash line is the 95 percentile in each year. The dash-dot line represents 5 percentile in each year. The lower panel uses another version of WACC $wacc_{GGM,HDZ5}$. $wacc_{GGM,HDZ5} = r_{E,GGM,HDZ5} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$. $r_{E,GGM,HDZ5}$ is the cost of equity using Gordon Growth Model. The construction details are in the Appendix.


CAPM,10Y
.05
.1
.15
.2
.25
.3
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Year
Median
95%
5%


GGM,HDZ5
0
.1
.2
.3
.4
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
Year
Median
95%
5%

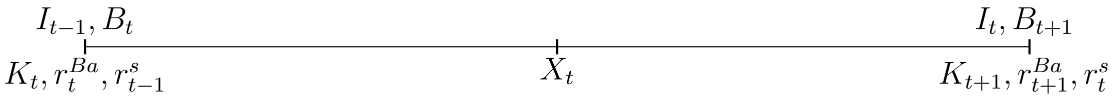


Figure 4: Sequence of events for date t. Note: the state variables for period t are K_t, B_t, and X_t. The choice variables for period t are shown above the time line, they are I_t, and B_{t+1}.

Table I: Descriptive Statistics

This table presents the descriptive statistics of the main variables in the paper. The firm level data is from the Compustat/CRSP merged data file.The sample period is from 1960 to 2010. We drop foreign companies, and the companies with a SIC code that is between 4900 and 4999, between 6000 and 6999, or greater 9000. We also drop the firms with total asset below 10 million dollars (in year 2004 dollars). The gross capital stock K is Item 7. Q is (Item 6 + Item 199×Item 25 - Item 60 -Item 74)/ Item 6. EBITDA is the sum of Item 14 and 18. Sale is the Item 12. Capital expenditure I is Item 128. Item numbers refer to COMPUSTAT annual data items. Data item 7 is lagged. $r_{E,CAPM,10Y}$ is the cost of equity using CAPM model. The risk free rate r_f is 10-year Treasury yield. $r_{E,FF3,10Y}$ is using Fama-French 3-factor model. $r_{E,FF4,10Y}$ is using Fama-French 3-factor and momentum factor. $r_{E,CAPM,1M}$ and $r_{E,FF4,1M}$ are constructed by using (annualized) 1- month Treasury yield. $r_{E,GGM,IBES1}$ is from the Gordon Growth Model using 1 year IBES earnings forecast. $r_{E,GGM,IBES5}$ is using 5-year IBES earnings forecast. $r_{E,GLS,IBES}$ is from Residual Income Model using IBES earnings forecast. $r_{E,GGM,HDZ1}$ is the same as $r_{E,GGM,IBES1}$ but using model predicted earnings. It is the same for $r_{E,GGM,HDZ5}$ and $r_{E,GLS,HDZ}$. Lev_{MKT} is market leverage;$Lev_{MKT,Net}$ is net market leverage; Lev_{BK} is book leverage; Lev_{WT} is $(Lev_{IND}+Lev_{MKT})/2$ where Lev_{IND} is the industry median leverage. $Lev_{MKT,TGT}$ is predicted leverage ratio. Tax_{SIM} is the simulated tax rate; Tax_{OLS} is the OLS regression predicted tax rate. Tax_{Top} is top tax rate in the corporation income tax brackets; Tax_{AV} is corporate average tax rate. $r_{D,INC}$ is the marginal cost of debt; $r_{D,AV}$ is the average cost of debt. The construction details are in the Appendix. All variables are winsorized at 1% level each tail every year. $wacc_{CAPM,10Y} = r_{E,CAPM,10Y} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$, $wacc_{FF4,10Y}$ is using $r_{E,FF4,10Y}$, $wacc_{GGM,HDZ5}$ is using $r_{E,GGM,HDZ5}$, and $wacc_{GLS,HDZ5}$ is using $r_{E,GLS,HDZ5}$.

	n	mean	median	std.	p5	p95
I/K	107240	0.168	0.114	0.187	0.024	0.497
Q	108850	1.577	1.244	1.113	0.720	3.589
C/K	97890	0.558	0.116	1.648	0.006	2.365
$EBITDA/K$	108610	0.128	0.162	0.772	-0.509	0.797
$Sales/K$	108733	4.468	2.721	5.953	0.404	14.735
$r_{E,CAPM,10Y}$	91694	0.164	0.163	0.058	0.070	0.263
$r_{E,FF3,10Y}$	91694	0.192	0.187	0.083	0.065	0.340
$r_{E,FF4,10Y}$	91694	0.179	0.175	0.102	0.018	0.354
$r_{E,CAPM,1M}$	91950	0.125	0.121	0.050	0.052	0.215
$r_{E,FF4,1M}$	91950	0.140	0.135	0.096	-0.007	0.309
$r_{E,GGM,HDZ1}$	70310	0.102	0.073	0.093	0.014	0.287
$r_{E,GGM,HDZ5}$	82700	0.127	0.095	0.102	0.025	0.341
$r_{E,GLS,HDZ}$	75815	0.125	0.119	0.064	0.031	0.251
$r_{E,GGM,IBES1}$	45445	0.053	0.041	0.047	0.005	0.147
$r_{E,GGM,IBES5}$	37118	0.073	0.065	0.048	0.012	0.166
$r_{E,GLS,IBES}$	39025	0.100	0.094	0.057	0.021	0.203
$r_{D,INC}$	101980	0.233	0.091	0.762	-0.055	0.868
$r_{D,AV}$	109715	0.108	0.084	0.128	0.032	0.227
Lev_{WT}	109511	0.201	0.186	0.118	0.029	0.418
Lev_{MKT}	109511	0.232	0.196	0.179	0.008	0.587
Lev_{BK}	109897	0.273	0.248	0.188	0.016	0.639
$Lev_{MKT,TGT}$	89951	0.292	0.289	0.111	0.118	0.480
$Lev_{MKT,Net}$	98521	0.196	0.153	0.189	0.000	0.575
Tax_{SIM}	66077	0.317	0.350	0.124	0.027	0.460
Tax_{OLS}	109906	0.320	0.364	0.064	0.187	0.364
Tax_{Top}	109906	0.402	0.350	0.065	0.340	0.520
Tax_{AV}	99432	0.341	0.380	0.159	0.000	0.530
$wacc_{CAPM,10Y}$	91220	0.142	0.139	0.049	0.066	0.228
$wacc_{FF4,10Y}$	91220	0.152	0.149	0.082	0.025	0.294
$wacc_{GGM,HDZ5}$	82386	0.108	0.086	0.076	0.029	0.265
$wacc_{GLS,HDZ5}$	75536	0.110	0.103	0.053	0.035	0.212
no. of firms	10863		avg. firm-year	21.05		

Table II: Weighted Average Cost of Capital: by Components

This table presents the descriptive statistics of Weighted Average Cost of Capital (WACC) by their components. The firm level data is from the Compustat/CRSP merged data file.The sample period is from 1960 to 2010. We drop foreign companies, and the companies with a SIC code that is between 4900 and 4999, between 6000 and 6999, or greater 9000. $r_{E,CAPM,10Y}$ is the cost of equity using CAPM model. The risk free rate r_f is 10-year Treasury yield. $r_{E,FF3,10Y}$ is using Fama-French 3-factor model. $r_{E,FF4,10Y}$ is using Fama-French 3-factor and momentum factor. $r_{E,CAPM,1M}$ and $r_{E,FF4,1M}$ are constructed by using (annualized) 1- month Treasury yield. $r_{E,GGM,IBES1}$ is from the Gordon Growth Model using 1 year IBES earnings forecast. $r_{E,GGM,IBES5}$ is using 5-year IBES earnings forecast. $r_{E,GLS,IBES}$ is from Residual Income Model using IBES earnings forecast. $r_{E,GGM,HDZ1}$ is the same as $r_{E,GGM,IBES1}$ but using model predicted earnings. It is the same for $r_{E,GGM,HDZ5}$ and $r_{E,GLS,HDZ}$. Lev_{MKT} is market leverage;$Lev_{MKT,Net}$ is net market leverage; Lev_{BK} is book leverage; Lev_{WT} is $(Lev_{IND}+Lev_{MKT})/2$ where Lev_{IND} is the industry median leverage. $Lev_{MKT,TGT}$ is predicted leverage ratio. Tax_{SIM} is the simulated tax rate; Tax_{OLS} is the OLS regression predicted tax rate. Tax_{Top} is top tax rate in the corporation income tax brackets; Tax_{AV} is corporate average tax rate. $r_{D,INC}$ is the marginal cost of debt; $r_{D,AV}$ is the average cost of debt. The construction details are in the Appendix. All variables are winsorized at 1% level each tail every year. We have 11 measures on cost of equity, 2 measures on cost of debt, 4 measures of taxes, and 5 measures of leverage. In total we have 440 WACCs. We keep the firm-year that has all the 440 WACC measures. It gives us 10786 firm-year observations and 4745840 of WACCs. For those WACCs, we group them by their components. For example, for the measure of cost of equity, we have 11 groups. For each group, we report the summary statistics in each column.

Group By	n	mean	median	std.	p5	p95
$r_{E,CAPM,10Y}$	431440	0.133	0.124	0.086	0.058	0.218
$r_{E,FF3,10Y}$	431440	0.155	0.145	0.093	0.062	0.260
$r_{E,FF4,10Y}$	431440	0.144	0.135	0.099	0.036	0.267
$r_{E,CAPM,1M}$	431440	0.110	0.101	0.082	0.051	0.182
$r_{E,FF4,1M}$	431440	0.121	0.111	0.097	0.022	0.239
$r_{E,GGM,HDZ1}$	431440	0.075	0.062	0.082	0.025	0.153
$r_{E,GGM,HDZ5}$	431440	0.084	0.070	0.084	0.036	0.162
$r_{E,GLS,HDZ}$	431440	0.098	0.091	0.082	0.032	0.162
$r_{E,GGM,IBES1}$	431440	0.063	0.051	0.081	0.017	0.134
$r_{E,GGM,IBES5}$	431440	0.080	0.069	0.082	0.027	0.151
$r_{E,GLS,IBES}$	431440	0.095	0.088	0.083	0.026	0.161
Tax_{SIM}	107860	0.095	0.088	0.084	0.026	0.161
Tax_{OLS}	107860	0.095	0.088	0.084	0.027	0.162
Tax_{TOP}	107860	0.094	0.088	0.082	0.026	0.160
Tax_{AV}	107860	0.095	0.088	0.083	0.026	0.161
Lev_{BK}	21572	0.093	0.086	0.090	0.027	0.153
Lev_{MKT}	21572	0.094	0.088	0.074	0.026	0.159
Lev_{WT}	21572	0.096	0.091	0.068	0.026	0.163
$Lev_{MKT,Net}$	21572	0.094	0.089	0.066	0.025	0.157
$Lev_{MKT,TGT}$	21572	0.097	0.085	0.108	0.028	0.178
$r_{D,INC}$	2372920	0.112	0.093	0.117	0.027	0.236
$r_{D,AV}$	2372920	0.098	0.089	0.053	0.031	0.197

Table III: Main Correlations

This table presents the correlation of the main variables in the paper. The firm level data is from the Compustat/CRSP merged data file.The sample period is from 1960 to 2010. We drop foreign companies, and the companies with a SIC code that is between 4900 and 4999, between 6000 and 6999, or greater 9000. We also drop the firms with total asset below 10 million dollars (in year 2004 dollars). The gross capital stock K is Item 7. Q is (Item 6 + Item 199×Item 25 - Item 60 -Item 74)/ Item 6. EBITDA is the sum of Item 14 and 18. Capital expenditure I is Item 128. Item numbers refer to COMPUSTAT annual data items. Data item 7 is lagged. $r_{E,CAPM,10Y}$ is the cost of equity using CAPM model. $r_{E,FF4,10Y}$ is using Fama-French 3-factor and momentum factor. $r_{E,GGM,HDZ5}$ is from Gordon Growth Model using model predicted earnings. $r_{E,GLS,HDZ}$ is from Residual Income Model. Lev_{MKT} is market leverage; Lev_{WT} is $(Lev_{IND}+Lev_{MKT})/2$ where Lev_{IND} is the industry median leverage. Tax_{SIM} is the simulated tax rate; Tax_{Top} is top tax rate in the corporation income tax brackets; Tax_{AV} is corporate average tax rate. $r_{D,AV}$ is the average cost of debt. The construction details are in the Appendix. All variables are winsorized at 1% level each tail every year. $wacc_{CAPM,10Y} = r_{E,CAPM,10Y} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$, and $wacc_{GGM,HDZ5}$ is using $r_{E,GGM,HDZ5}$ and the other components are the same as $wacc_{CAPM,10Y}$. *significant at 5% level. **significant at 1 % level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
I/K	1.00													
Q	0.31^{**}	1.00												
$EBITDA/K$	0.03^{**}	-0.10^{**}	1.00											
$r_{E,CAPM,10Y}$	0.14^{**}	0.01^{**}	-0.04^{**}	1.00										
$r_{E,FF4,10Y}$	0.07^{**}	-0.12^{**}	0.05^{**}	0.40^{**}	1.00									
$r_{E,GGM,HDZ5}$	-0.15^{**}	-0.35^{**}	-0.06^{**}	0.07^{**}	0.11^{**}	1.00								
$r_{E,GLS,HDZ}$	-0.00	-0.01^{**}	-0.17^{**}	0.15^{**}	0.08^{**}	0.57^{**}	1.00							
$r_{D,AV}$	-0.01^{**}	0.06^{**}	-0.08^{**}	0.06^{**}	0.01^{**}	0.01^{*}	0.08^{**}	1.00						
Tax_{SIM}	0.02^{**}	-0.18^{**}	0.37^{**}	0.14^{**}	0.16^{**}	0.03^{**}	-0.08^{**}	-0.06^{**}	1.00					
Tax_{Top}	-0.01^{*}	-0.17^{**}	0.09^{**}	0.36^{**}	0.24^{**}	0.34^{**}	0.20^{**}	-0.09^{**}	0.47^{**}	1.00				
Lev_{WT}	-0.10^{**}	-0.42^{**}	-0.02^{**}	0.08^{**}	0.16^{**}	0.37^{**}	0.12^{**}	-0.16^{**}	0.08^{**}	0.17^{**}	1.00			
Lev_{MKT}	-0.10^{**}	-0.37^{**}	-0.07^{**}	0.05^{**}	0.11^{**}	0.33^{**}	0.13^{**}	-0.17^{**}	-0.01	0.07^{**}	0.93^{**}	1.00		
$wacc_{CAPM,10Y}$	0.15^{**}	0.13^{**}	-0.04^{**}	0.94^{**}	0.34^{**}	-0.03^{**}	0.12^{**}	0.20^{**}	0.09^{**}	0.25^{**}	-0.20^{**}	-0.21^{**}	1.00	
$wacc_{GGM,HDZ5}$	-0.16^{**}	-0.34^{**}	-0.06^{**}	0.06^{**}	0.10^{**}	0.97^{**}	0.59^{**}	0.09^{**}	0.02^{**}	0.30^{**}	0.24^{**}	0.21^{**}	0.01^{*}	1.00

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

Table IV: I/K: Two-way sorts

The four panels in this table report the two-way sorts results of I/K. The firm level data is from the Compustat/CRSP merged data file.The sample period is from 1960 to 2010. We drop foreign companies, and the companies with a SIC code that is between 4900 and 4999, between 6000 and 6999, or greater 9000. We also drop the firms with total asset below 10 million dollars (in year 2004 dollars). The gross capital stock K is Item 7. Q is (Item 6 + Item 199×Item 25 - Item 60 -Item 74)/ Item 6. EBITDA is the sum of Item 14 and 18. Capital expenditure I is Item 128. Item numbers refer to COMPUSTAT annual data items. Data item 7 is lagged. $r_{E,CAPM,10Y}$ is the cost of equity using CAPM model. $r_{E,GGM,HDZ5}$ is from Gordon Growth Model using model predicted earnings. Lev_{MKT} is market leverage; Lev_{WT} is $(Lev_{IND}+Lev_{MKT})/2$ where Lev_{IND} is the industry median leverage. Tax_{Top} is top tax rate in the corporation income tax brackets. $r_{D,AV}$ is the average cost of debt. The construction details are in the Appendix. All variables are winsorized at 1% level each tail every year. $wacc_{CAPM,10Y} = r_{E,CAPM,10Y} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$, and $wacc_{GGM,HDZ5}$ is using $r_{E,GGM,HDZ5}$ and the other components are the same as $wacc_{CAPM,10Y}$. We sort the firms into 5×5 groups by one WACC measure ($wacc_{CAPM,10Y}$ or $wacc_{GGM,HDZ5}$) and one control variable ($EBITDA/K$ or Q). The median of I/K in each group is reported. High-Low measures the mean differences between "High" group and "Low" group in each row/column. Assuming that the two groups have different variance, we test whether the differences are significant. *significant at 5% level. **significant at 1 % level.

$EBITDA/K$

$wacc_{CAPM,10Y}$	1(Low)	2	3	4	5(High)	Total	High-Low
1 (Low)	0.066	0.089	0.109	0.128	0.167	0.095	0.151**
2	0.070	0.087	0.111	0.129	0.164	0.104	0.128**
3	0.070	0.084	0.111	0.133	0.165	0.111	0.106**
4	0.081	0.083	0.112	0.135	0.179	0.121	0.095**
5 (High)	0.096	0.091	0.119	0.148	0.222	0.147	0.111**
Total	0.074	0.087	0.112	0.135	0.187	0.114	0.136**
High-Low	0.066**	0.006**	0.000	0.010**	0.027**	0.065**	

$EBITDA/K$

$wacc_{GGM,HDZ5}$	1(Low)	2	3	4	5(High)	Total	High-Low
1 (Low)	0.124	0.117	0.152	0.180	0.257	0.179	0.112**
2	0.094	0.103	0.127	0.146	0.188	0.133	0.096**
3	0.082	0.091	0.111	0.132	0.177	0.115	0.106**
4	0.077	0.083	0.104	0.123	0.169	0.104	0.109**
5 (High)	0.060	0.070	0.093	0.115	0.150	0.087	0.112**
Total	0.081	0.088	0.114	0.138	0.197	0.120	0.136**
High-Low	-0.121**	-0.073**	-0.079**	-0.081**	-0.116**	-0.124**	

Q

$wacc_{CAPM,10Y}$	1(Low)	2	3	4	5(High)	Total	High-Low
1 (Low)	0.074	0.095	0.106	0.117	0.141	0.095	0.129**
2	0.075	0.095	0.115	0.126	0.148	0.104	0.104**
3	0.075	0.099	0.114	0.131	0.156	0.111	0.107**
4	0.078	0.100	0.116	0.135	0.169	0.121	0.122**
5 (High)	0.081	0.108	0.121	0.149	0.216	0.147	0.176**
Total	0.076	0.098	0.114	0.134	0.176	0.114	0.182**
High-Low	0.004	0.009**	0.005	0.019**	0.050**	0.065**	

Q

$wacc_{GGM,HDZ5}$	1(Low)	2	3	4	5(High)	Total	High-Low
1 (Low)	0.082	0.109	0.141	0.181	0.230	0.179	0.190**
2	0.082	0.109	0.127	0.143	0.168	0.133	0.119**
3	0.086	0.105	0.119	0.129	0.162	0.114	0.112**
4	0.080	0.100	0.113	0.128	0.161	0.104	0.132**
5 (High)	0.071	0.090	0.096	0.108	0.145	0.087	0.125**
Total	0.079	0.102	0.119	0.140	0.191	0.120	0.183**
High-Low	-0.022**	-0.031**	-0.051**	-0.079**	-0.087**	-0.124**	

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

Table V: Timing of WACC: Contemporaneous and Lagged

This table reports the estimates from the panel regressions. The firm level data is from the Compustat/CRSP merged data file.The sample period is from 1960 to 2010. We drop foreign companies, and the companies with a SIC code that is between 4900 and 4999, between 6000 and 6999, or greater 9000. We also drop the firms with total asset below 10 million dollars (in year 2004 dollars). The gross capital stock K is Item 7. Q is (Item 6 + Item 199×Item 25 - Item 60 -Item 74)/ Item 6. EBITDA is the sum of Item 14 and 18. Capital expenditure I is Item 128. Item numbers refer to COMPUSTAT annual data items. Data item 7 is lagged. The model we estimate is

$$I_{i,t}/K_{i,t-1} \quad = \quad \alpha_0 + \alpha_1 Q_{i,t-1} + \alpha_2 EBITDA_{i,t}/K_{i,t-1} + \alpha_3 wacc_i + \sum_i Ind._i + \sum_t year_t + \varepsilon_{i,t}.$$

The industry and year fixed effects are included. The standard errors are clustered at both firm and year dimensions. Columns (1) to (4) contain the estimates using contemporaneous WACC's. Columns (5) to (8) contain the estimates using one period lagged WACC's. The row under the column number indicates which WACC we use, and the WACC is suppressed. $wacc_{CAPM,10Y} = r_{E,CAPM,10Y} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$, $wacc_{FF4,10Y} = r_{E,FF4,10Y} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$, $wacc_{GGM,HDZ5} = r_{E,GGM,HDZ5} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$, $wacc_{GLS,HDZ5} = r_{E,GLS,HDZ5} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$. $r_{E,CAPM,10Y}$ is the cost of equity using CAPM model. $r_{E,FF4,10Y}$ is using Fama-French 3-factor and momentum factor. $r_{E,GGM,HDZ5}$ is from Gordon Growth Model using model predicted earnings. $r_{E,GLS,HDZ}$ is from Residual Income Model. Lev_{MKT} is market leverage; Lev_{WT} is $(Lev_{IND} + Lev_{MKT})/2$ where Lev_{IND} is the industry median leverage. Tax_{Top} is top tax rate in the corporation income tax brackets. $r_{D,AV}$ is the average cost of debt. The construction details are in the Appendix. All variables are winsorized at 1% level each tail every year.

	Contemporaneous				lagged			
	(1) CAPM,10Y	(2) FF4,10Y	(3) GGM,HDZ5	(4) GLS,HDZ5	(5) CAPM,10Y	(6) FF4,10Y	(7) GGM,HDZ5	(8) GLS,HDZ5
Q	0.044***	0.045***	0.047***	0.051***	0.039***	0.041***	0.043***	0.046***
	(13.47)	(13.53)	(12.52)	(11.04)	(14.01)	(13.82)	(12.72)	(11.38)
$EBITDA/K$	0.016**	0.015**	0.014**	0.017***	0.023***	0.022***	0.025***	0.025***
	(2.43)	(2.24)	(2.09)	(2.65)	(4.20)	(3.92)	(4.35)	(3.52)
WACC	0.174***	0.073***	-0.217***	-0.094***	0.257***	0.101***	-0.146***	0.014
	(4.19)	(4.19)	(-8.96)	(-4.15)	(5.62)	(5.16)	(-7.71)	(0.56)
Yr. and Ind.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	88753	88753	81129	74359	79596	79596	72090	66002
Adj. R^2	0.139	0.139	0.163	0.155	0.142	0.140	0.157	0.150

t statistics in parentheses

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

Table VI: Timing of WACC: Contemporaneous and Lagged, with a Different Proxy for Cash Flows

This table reports the estimates from the panel regressions. The firm level data is from the Compustat/CRSP merged data file.The sample period is from 1960 to 2010. We drop foreign companies, and the companies with a SIC code that is between 4900 and 4999, between 6000 and 6999, or greater 9000. We also drop the firms with total asset below 10 million dollars (in year 2004 dollars). The gross capital stock K is Item 7. Q is (Item 6 + Item 199×Item 25 - Item 60 -Item 74)/ Item 6. Sale is the Item 12. Capital expenditure I is Item 128. Item numbers refer to COMPUSTAT annual data items. Data item 7 is lagged. The model we estimate is

$$I_{i,t}/K_{i,t-1} \;=\; \alpha_0 + \alpha_1 Q_{i,t-1} + \alpha_2 Sales_{i,t}/K_{i,t-1} + \alpha_3 wacc_i + \sum_i Ind._i + \sum_t year_t + \varepsilon_{i,t}.$$

The industry and year fixed effects are included. The standard errors are clustered at both firm and year dimensions. Columns (1) to (4) contain the estimates using contemporaneous WACC's. Columns (5) to (8) contain the estimates using one period lagged WACC's. The row under the column number indicates which WACC we use, and the WACC is suppressed. $wacc_{CAPM,10Y} = r_{E,CAPM,10Y} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$, $wacc_{FF4,10Y} = r_{E,FF4,10Y} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$, $wacc_{GGM,HDZ5} = r_{E,GGM,HDZ5} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$, $wacc_{GLS,HDZ5} = r_{E,GLS,HDZ5} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$. $r_{E,CAPM,10Y}$ is the cost of equity using CAPM model. $r_{E,FF4,10Y}$ is using Fama-French 3-factor and momentum factor. $r_{E,GGM,HDZ5}$ is from Gordon Growth Model using model predicted earnings. $r_{E,GLS,HDZ}$ is from Residual Income Model. Lev_{MKT} is market leverage; Lev_{WT} is $(Lev_{IND} + Lev_{MKT})/2$ where Lev_{IND} is the industry median leverage. Tax_{Top} is top tax rate in the corporation income tax brackets. $r_{D,AV}$ is the average cost of debt. The construction details are in the Appendix. All variables are winsorized at 1% level each tail every year.

	Contemporaneous				lagged			
	(1) CAPM,10Y	(2) FF4,10Y	(3) GGM,HDZ5	(4) GLS,HDZ5	(5) CAPM,10Y	(6) FF4,10Y	(7) GGM,HDZ5	(8) GLS,HDZ5
Q	0.042***	0.043***	0.044***	0.048***	0.039***	0.040***	0.041***	0.044***
	(13.34)	(13.45)	(12.77)	(11.07)	(13.24)	(13.13)	(12.61)	(10.92)
$Sales/K$	0.008***	0.008***	0.009***	0.009***	0.007***	0.007***	0.008***	0.008***
	(20.27)	(20.16)	(18.34)	(18.09)	(19.95)	(19.79)	(19.33)	(17.90)
WACC	0.107***	0.054***	-0.254***	-0.173***	0.184***	0.081***	-0.187***	-0.075***
	(2.91)	(3.30)	(-11.42)	(-8.24)	(4.49)	(4.54)	(-10.05)	(-3.81)
Yr. and Ind.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	88812	88812	81165	74396	79645	79645	72123	66033
Adj. R^2	0.201	0.201	0.228	0.218	0.191	0.191	0.208	0.200

t statistics in parentheses

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

Table VII: By Decades

This table reports the estimates from the panel regressions by decades. The firm level data is from the Compustat/CRSP merged data file.The sample period is from 1960 to 2010. We drop foreign companies, and the companies with a SIC code that is between 4900 and 4999, between 6000 and 6999, or greater 9000. We also drop the firms with total asset below 10 million dollars (in year 2004 dollars). The gross capital stock K is Item 7. Q is (Item 6 + Item 199×Item 25 - Item 60 -Item 74)/ Item 6. EBITDA is the sum of Item 14 and 18. Sale is the Item 12. Capital expenditure I is Item 128. Item numbers refer to COMPUSTAT annual data items. Data item 7 is lagged. The model we estimate is

$$I_{i,t}/K_{i,t-1} \;\;=\;\; \alpha_0 + \alpha_1 Q_{i,t-1} + \alpha_2 CashFlowi,t/K_{i,t-1} + \alpha_3 wacc_{i,t} + \sum_i Ind._i + \sum_t year_t + \varepsilon_{i,t}.$$

The industry and year fixed effects are included. The standard errors are clustered at both firm and year dimensions. In the upper panel, the cash flow proxy is EBITDA. In the lower panel, the cash flow proxy is Sales. $wacc_{CAPM,10Y} = r_{E,CAPM,10Y} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$, $wacc_{GGM,HDZ5} = r_{E,GGM,HDZ5} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$. $r_{E,CAPM,10Y}$ is the cost of equity using CAPM model. $r_{E,GGM,HDZ5}$ is from Gordon Growth Model using model predicted earnings. Lev_{MKT} is market leverage; Lev_{WT} is $(Lev_{IND}+Lev_{MKT})/2$ where Lev_{IND} is the industry median leverage. Tax_{Top} is top tax rate in the corporation income tax brackets. $r_{D,AV}$ is the average cost of debt. The construction details are in the Appendix. All variables are winsorized at 1% level each tail every year.

	(60-69)		(70-79)		(80-89)		(90-99)		(00-10)	
Q	0.017***	0.015**	0.041***	0.040***	0.076***	0.081***	0.048***	0.053***	0.030***	0.029***
	(4.30)	(2.19)	(5.73)	(6.18)	(10.89)	(14.27)	(10.58)	(13.30)	(17.81)	(17.72)
$EBITDA/K$	0.329***	0.360***	0.212***	0.212***	0.145***	0.137***	0.014**	0.013**	-0.002	-0.006
	(14.51)	(14.95)	(12.69)	(13.48)	(7.61)	(5.78)	(1.99)	(2.07)	(-0.35)	(-0.94)
$wacc_{CAPM,10Y}$	0.152***		0.057		0.072		0.214***		0.020	
	(3.88)		(0.85)		(1.12)		(4.93)		(0.36)	
$wacc_{GGM,HDZ5}$		-0.056**		-0.108***		-0.161***		-0.320***		-0.189***
		(-2.42)		(-4.05)		(-5.61)		(-6.12)		(-4.75)
Yr. and Ind.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	5445	3083	15998	17022	21115	19142	22055	21925	22411	19957
Adj. R^2	0.319	0.373	0.258	0.270	0.207	0.231	0.126	0.155	0.150	0.172

Q	0.034***	0.034***	0.058***	0.056***	0.085***	0.086***	0.045***	0.049***	0.029***	0.028***
	(9.63)	(7.05)	(6.34)	(6.91)	(9.34)	(11.35)	(11.07)	(15.06)	(17.00)	(14.94)
$Sales/K$	0.014***	0.015***	0.007***	0.008***	0.011***	0.012***	0.009***	0.010***	0.006***	0.006***
	(16.36)	(12.62)	(10.96)	(12.39)	(10.07)	(8.60)	(19.06)	(15.55)	(12.69)	(8.26)
$wacc_{CAPM}$	0.130***		0.165***		0.095		0.142***		0.030	
	(3.21)		(3.10)		(1.37)		(3.49)		(0.47)	
$wacc_{GGM}$		-0.136***		-0.171***		-0.254***		-0.346***		-0.189***
		(-3.94)		(-5.26)		(-7.59)		(-7.06)		(-6.21)
Yr. and Ind.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	5449	3085	16000	17024	21127	19147	22081	21943	22426	19966
Adj. R^2	0.297	0.327	0.217	0.232	0.214	0.247	0.209	0.243	0.213	0.231

t statistics in parentheses

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

Table VIII: All WACC's (Part I)

This table reports the estimates from the panel regressions for all WACC's. The firm level data is from the Compustat/CRSP merged data file.The sample period is from 1960 to 2010. We drop foreign companies, and the companies with a SIC code that is between 4900 and 4999, between 6000 and 6999, or greater 9000. We also drop the firms with total asset below 10 million dollars (in year 2004 dollars). The gross capital stock K is Item 7. Q is (Item 6 + Item 199×Item 25 - Item 60 -Item 74)/ Item 6. EBITDA is the sum of Item 14 and 18. Capital expenditure I is Item 128. Item numbers refer to COMPUSTAT annual data items. Data item 7 is lagged. The model we estimate is

$$I_{i,t}/K_{i,t-1} \quad = \quad \alpha_0 + \alpha_1 Q_{i,t-1} + \alpha_2 EBITDAi,t/K_{i,t-1} + \alpha_3 wacc_{i,t} + \sum_i Ind._i + \sum_t year_t + \varepsilon_{i,t}.$$

The industry and year fixed effects are included. The standard errors are clustered at both firm and year dimensions. $r_{E,CAPM,10Y}$ is the cost of equity using CAPM model. The risk free rate r_f is 10-year Treasury yield. $r_{E,FF3,10Y}$ is using Fama-French 3-factor model. $r_{E,FF4,10Y}$ is using Fama-French 3-factor and momentum factor. $r_{E,CAPM,1M}$ and $r_{E,FF4,1M}$ are constructed by using (annualized) 1- month Treasury yield. $r_{E,GGM,IBES1}$ is from the Gordon Growth Model using 1 year IBES earnings forecast. $r_{E,GGM,IBES5}$ is using 5-year IBES earnings forecast. $r_{E,GLS,IBES}$ is from Residual Income Model using IBES earnings forecast. $r_{E,GGM,HDZ1}$ is the same as $r_{E,GGM,IBES1}$ but using model predicted earnings. It is the same for $r_{E,GGM,HDZ5}$ and $r_{E,GLS,HDZ}$. Lev_{MKT} is market leverage;$Lev_{MKT,Net}$ is net market leverage; Lev_{BK} is book leverage; Lev_{WT} is $(Lev_{IND}+Lev_{MKT})/2$ where Lev_{IND} is the industry median leverage. $Lev_{MKT,TGT}$ is predicted leverage ratio. Tax_{SIM} is the simulated tax rate; Tax_{OLS} is the OLS regression predicted tax rate. Tax_{Top} is top tax rate in the corporation income tax brackets; Tax_{AV} is corporate average tax rate. $r_{D,INC}$ is the marginal cost of debt; $r_{D,AV}$ is the average cost of debt. The construction details are in the Appendix. All variables are winsorized at 1% level each tail every year. $wacc = r_E \times (1 - Lev) + r_D \times Lev \times (1 - Tax)$. We have 11 measures on cost of equity, 2 measures on cost of debt, 5 measures on leverage and 4 measures on tax rates. The coefficients of those 440 WACC's, calculated by the components in rows and columns, are reported.

	Tax_{SIM}									
	Lev_{BK}		Lev_{MKT}		Lev_{WT}		$Lev_{MKT,Net}$		$Lev_{MKT,TGT}$	
	$r_{D,INC}$	$r_{D,AV}$	$r_{D,INC}$	$r_{D,AV}$	$r_{D,INC}$	$r_{D,AV}$	$r_{D,INC}$	$r_{D,AV}$	$r_{D,INC}$	$r_{D,AV}$
$r_{E,CAPM,10Y}$	0.006	0.101**	0.013**	0.178***	0.021**	0.191***	0.016**	0.190***	-0.001	0.084**
$r_{E,FF3,10Y}$	-0.001	-0.016	-0.001	0.018	-0.004	0.014	-0.003	0.023	-0.008*	-0.014
$r_{E,FF4,10Y}$	0.005	0.032*	0.011	0.056***	0.016	0.056***	0.012	0.058***	0.002	0.040**
$r_{E,CAPM,1M}$	0.007	0.120**	0.010	0.165***	0.017**	0.172***	0.013*	0.183***	-0.002	0.063*
$r_{E,FF4,1M}$	0.006	0.034*	0.008	0.049**	0.013	0.049**	0.010	0.052***	0.001	0.033*
$r_{E,GGM,HDZ1}$	-0.039***	-0.276***	-0.062***	-0.276***	-0.084***	-0.244***	-0.080***	-0.249***	-0.028***	-0.206***
$r_{E,GGM,HDZ5}$	-0.047***	-0.291***	-0.078***	-0.287***	-0.109***	-0.265***	-0.102***	-0.262***	-0.043***	-0.241***
$r_{E,GLS,HDZ}$	-0.018***	-0.176***	-0.030***	-0.145***	-0.044***	-0.130***	-0.040***	-0.125***	-0.025***	-0.158***
$r_{E,GGM,IBES1}$	-0.016***	-0.190***	-0.028***	-0.198***	-0.039***	-0.161***	-0.038***	-0.173***	-0.015***	-0.138***
$r_{E,GGM,IBES5}$	0.000	-0.069	-0.011	-0.055	-0.015	-0.025	-0.023**	-0.034	-0.003	-0.018
$r_{E,GLS,IBES}$	-0.003	-0.067	-0.009	-0.069*	-0.012	-0.042	-0.019***	-0.041	-0.009*	-0.097***

	Tax_{OLS}									
	Lev_{BK}		Lev_{MKT}		Lev_{WT}		$Lev_{MKT,Net}$		$Lev_{MKT,TGT}$	
	$r_{D,INC}$	$r_{D,AV}$	$r_{D,INC}$	$r_{D,AV}$	$r_{D,INC}$	$r_{D,AV}$	$r_{D,INC}$	$r_{D,AV}$	$r_{D,INC}$	$r_{D,AV}$
$r_{E,CAPM,10Y}$	0.005	0.046	0.013*	0.132***	0.022**	0.151***	0.010	0.133***	-0.000	0.081**
$r_{E,FF3,10Y}$	-0.003	-0.025	0.000	0.019	-0.001	0.017	-0.007	0.017	-0.007	-0.003
$r_{E,FF4,10Y}$	0.007	0.034**	0.016**	0.065***	0.023**	0.067***	0.013	0.060***	0.006	0.060***
$r_{E,CAPM,1M}$	0.007	0.072*	0.011	0.126***	0.019**	0.140***	0.007	0.128***	-0.002	0.064*
$r_{E,FF4,1M}$	0.008	0.041**	0.015*	0.061***	0.021**	0.063***	0.011	0.056***	0.005	0.055***
$r_{E,GGM,HDZ1}$	-0.051***	-0.213***	-0.073***	-0.215***	-0.092***	-0.195***	-0.092***	-0.199***	-0.036***	-0.185***
$r_{E,GGM,HDZ5}$	-0.052***	-0.239***	-0.083***	-0.233***	-0.110***	-0.221***	-0.107***	-0.231***	-0.050***	-0.213***
$r_{E,GLS,HDZ}$	-0.018***	-0.153***	-0.029***	-0.117***	-0.042***	-0.106***	-0.043***	-0.116***	-0.024***	-0.138***
$r_{E,GGM,IBES1}$	-0.021***	-0.218***	-0.031***	-0.224***	-0.042***	-0.181***	-0.039***	-0.192***	-0.015**	-0.163***
$r_{E,GGM,IBES5}$	-0.010**	-0.103**	-0.014**	-0.085*	-0.012	-0.043	-0.026***	-0.061	0.007	-0.010
$r_{E,GLS,IBES}$	-0.009**	-0.107***	-0.014**	-0.113***	-0.017*	-0.079**	-0.023***	-0.080**	-0.005	-0.119***

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

Table IX: All WACC's (Part II)

	Tax_{Top}									
	Lev_{BK}		Lev_{MKT}		Lev_{WT}		$Lev_{MKT,Net}$		$Lev_{MKT,TGT}$	
	$r_{D,INC}$	$r_{D,AV}$	$r_{D,INC}$	$r_{D,AV}$	$r_{D,INC}$	$r_{D,AV}$	$r_{D,INC}$	$r_{D,AV}$	$r_{D,INC}$	$r_{D,AV}$
$r_{E,CAPM,10Y}$	0.007	0.068*	0.020**	0.155***	0.032***	0.174***	0.019**	0.151***	0.004	0.114***
$r_{E,FF3,10Y}$	-0.003	-0.015	0.004	0.029	0.003	0.026	-0.003	0.026	-0.005	0.009
$r_{E,FF4,10Y}$	0.009	0.041**	0.022**	0.072***	0.030***	0.073***	0.019*	0.065***	0.010*	0.069***
$r_{E,CAPM,1M}$	0.010	0.099**	0.018**	0.154***	0.029**	0.164***	0.016*	0.151***	0.002	0.097**
$r_{E,FF4,1M}$	0.011*	0.049***	0.020**	0.069***	0.027**	0.069***	0.017*	0.062***	0.009	0.064***
$r_{E,GGM,HDZ1}$	-0.058***	-0.213***	-0.081***	-0.212***	-0.098***	-0.192***	-0.099***	-0.196***	-0.039***	-0.182***
$r_{E,GGM,HDZ5}$	-0.061***	-0.235***	-0.092***	-0.227***	-0.119***	-0.217***	-0.117***	-0.225***	-0.055***	-0.210***
$r_{E,GLS,HDZ}$	-0.021***	-0.139***	-0.031***	-0.100***	-0.043***	-0.094***	-0.045***	-0.101***	-0.025***	-0.128***
$r_{E,GGM,IBES1}$	-0.026***	-0.227***	-0.036***	-0.225***	-0.046***	-0.180***	-0.045***	-0.193***	-0.016**	-0.167***
$r_{E,GGM,IBES5}$	-0.012***	-0.095**	-0.017**	-0.076	-0.015*	-0.037	-0.029***	-0.053	0.005	-0.010
$r_{E,GLS,IBES}$	-0.012**	-0.088**	-0.017**	-0.098***	-0.019**	-0.069**	-0.026***	-0.068**	-0.006	-0.114***

	Tax_{AV}									
	Lev_{BK}		Lev_{MKT}		Lev_{WT}		$Lev_{MKT,Net}$		$Lev_{MKT,TGT}$	
	$r_{D,INC}$	$r_{D,AV}$	$r_{D,INC}$	$r_{D,AV}$	$r_{D,INC}$	$r_{D,AV}$	$r_{D,INC}$	$r_{D,AV}$	$r_{D,INC}$	$r_{D,AV}$
$r_{E,CAPM,10Y}$	0.010	0.066*	0.021***	0.165***	0.033***	0.194***	0.017**	0.166***	0.006	0.122***
$r_{E,FF3,10Y}$	0.002	-0.013	0.007	0.035*	0.008	0.037*	-0.001	0.031*	-0.001	0.020
$r_{E,FF4,10Y}$	0.010*	0.038**	0.021***	0.070***	0.030***	0.075***	0.016*	0.063***	0.011*	0.068***
$r_{E,CAPM,1M}$	0.012*	0.101***	0.019**	0.167***	0.031***	0.186***	0.015*	0.169***	0.005	0.107***
$r_{E,FF4,1M}$	0.012**	0.047***	0.020**	0.068***	0.028***	0.071***	0.015	0.061***	0.010*	0.063***
$r_{E,GGM,HDZ1}$	-0.053***	-0.209***	-0.081***	-0.212***	-0.098***	-0.193***	-0.105***	-0.198***	-0.034***	-0.177***
$r_{E,GGM,HDZ5}$	-0.052***	-0.234***	-0.086***	-0.228***	-0.113***	-0.217***	-0.113***	-0.231***	-0.045***	-0.201***
$r_{E,GLS,HDZ}$	-0.013**	-0.130***	-0.023***	-0.090***	-0.032***	-0.079***	-0.039***	-0.094***	-0.017**	-0.106***
$r_{E,GGM,IBES1}$	-0.023***	-0.195***	-0.031***	-0.202***	-0.040***	-0.161***	-0.039***	-0.177***	-0.012	-0.125***
$r_{E,GGM,IBES5}$	-0.009**	-0.076	-0.009	-0.055	-0.006	-0.015	-0.021**	-0.038	0.011	0.027
$r_{E,GLS,IBES}$	-0.007*	-0.061	-0.008	-0.066*	-0.007	-0.029	-0.018**	-0.041	0.001	-0.068**

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

Table X: Decomposition I

This table reports the estimates from the panel regressions of the WACC decomposition. The firm level data is from the Compustat/CRSP merged data file. The sample period is from 1960 to 2010. We drop foreign companies, and the companies with a SIC code that is between 4900 and 4999, between 6000 and 6999, or greater 9000. We also drop the firms with total asset below 10 million dollars (in year 2004 dollars). The gross capital stock K is Item 7. Q is (Item 6 + Item 199×Item 25 - Item 60 -Item 74)/ Item 6. EBITDA is the sum of Item 14 and 18. Capital expenditure I is Item 128. Item numbers refer to COMPUSTAT annual data items. Data item 7 is lagged. The model we estimate is

$$I_{i,t}/K_{i,t-1} = \alpha_0 + \alpha_1 Q_{i,t-1} + \alpha_2 EBITDA_{i,t}/K_{i,t-1} + \alpha_3 Lev_{WT,i,t} + \alpha_4 r_{D,AV,i,t} + \alpha_5 Tax_{Top,t} + \alpha_6 r_{E,i,t} + \sum_i Ind._i + \sum_t year_t + \varepsilon_{i,t}.$$

The industry and year fixed effects are included. The standard errors are clustered at both firm and year dimensions. The first row indicates which measure of cost of equity we use. The r_E is suppressed. $r_{E,CAPM,10Y}$ is the cost of equity using CAPM model. The risk free rate r_f is 10-year Treasury yield. $r_{E,FF3,10Y}$ is using Fama-French 3-factor model. $r_{E,FF4,10Y}$ is using Fama-French 3-factor and momentum factor. $r_{E,CAPM,1M}$ and $r_{E,FF4,1M}$ are constructed by using (annualized) 1- month Treasury yield. $r_{E,GGM,IBES1}$ is from the Gordon Growth Model using 1 year IBES earnings forecast. $r_{E,GGM,IBES5}$ is using 5-year IBES earnings forecast. $r_{E,GLS,IBES}$ is from Residual Income Model using IBES earnings forecast. $r_{E,GGM,HDZ1}$ is the same as $r_{E,GGM,IBES1}$ but using model predicted earnings. It is the same for $r_{E,GGM,HDZ5}$ and $r_{E,GLS,HDZ}$. Lev_{MKT} is market leverage;Lev_{WT} is $(Lev_{IND}+Lev_{MKT})/2$ where Lev_{IND} is the industry median leverage. Tax_{Top} is top tax rate in the corporation income tax brackets. $r_{D,AV}$ is the average cost of debt. The construction details are in the Appendix. All variables are winsorized at 1% level each tail every year.

	CAPM,10Y	FF4,10Y	CAPM,1M	FF4,1M	GGM,HDZ5	GLS,HDZ	GGM,IBES1	GLS,IBES
Q	0.042***	0.044***	0.043***	0.044***	0.047***	0.049***	0.054***	0.053***
	(13.51)	(13.83)	(13.61)	(13.79)	(12.14)	(10.90)	(8.87)	(9.53)
$EBITDA/K$	0.019***	0.017**	0.019**	0.018**	0.017**	0.021***	0.046***	0.005
	(2.60)	(2.31)	(2.53)	(2.36)	(2.33)	(2.90)	(5.28)	(0.90)
Lev_{WT}	0.037*	0.047**	0.059**	0.057**	0.067***	0.028	0.151***	0.058*
	(1.69)	(2.09)	(2.43)	(2.41)	(2.97)	(1.32)	(4.25)	(1.85)
$r_{D,AV}$	-0.043***	-0.034***	-0.031***	-0.030***	-0.035***	-0.044***	-0.012	-0.035***
	(-4.07)	(-3.41)	(-3.05)	(-2.94)	(-3.33)	(-3.51)	(-1.00)	(-2.94)
Tax_{Top}	0.119**	0.193***	0.218***	0.227***	0.367***	0.347***	0.476***	0.390***
	(2.21)	(3.47)	(3.54)	(3.79)	(5.39)	(5.24)	(5.99)	(5.12)
r_E	0.329***	0.123***	0.161***	0.072***	-0.157***	-0.024	-0.210***	-0.028
	(6.60)	(5.80)	(4.23)	(4.37)	(-9.28)	(-0.78)	(-4.93)	(-0.79)
Ind.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	88753	88753	88990	88990	81129	74359	44524	38211
Adj. R^2	0.116	0.110	0.107	0.106	0.133	0.126	0.173	0.135

t statistics in parentheses

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

Table XI: Decomposition II

This table reports the estimates from the panel regressions of the WACC decomposition. The firm level data is from the Compustat/CRSP merged data file. The sample period is from 1960 to 2010. We drop foreign companies, and the companies with a SIC code that is between 4900 and 4999, between 6000 and 6999, or greater 9000. We also drop the firms with total asset below 10 million dollars (in year 2004 dollars). The gross capital stock K is Item 7. Q is (Item 6 + Item 199×Item 25 - Item 60 -Item 74)/ Item 6. EBITDA is the sum of Item 14 and 18. Capital expenditure I is Item 128. Item numbers refer to COMPUSTAT annual data items. Data item 7 is lagged. The model we estimate is

$$I_{i,t}/K_{i,t-1} \quad = \quad \alpha_0 + \alpha_1 Q_{i,t-1} + \alpha_2 EBITDA_{i,t}/K_{i,t-1} + \alpha_3 Lev_{WT,i,t} + \alpha_4 r_{D,AV,i,t} + \alpha_5 Tax_{SIM,t} + \alpha_6 r_{E,i,t} + \sum_i Ind._i + \sum_t year_t + \varepsilon_{i,t}.$$

The industry and year fixed effects are included. The standard errors are clustered at both firm and year dimensions. The first row indicates which measure of cost of equity we use. The r_E is suppressed. $r_{E,CAPM,10Y}$ is the cost of equity using CAPM model. The risk free rate r_f is 10-year Treasury yield. $r_{E,FF3,10Y}$ is using Fama-French 3-factor model. $r_{E,FF4,10Y}$ is using Fama-French 3-factor and momentum factor. $r_{E,CAPM,1M}$ and $r_{E,FF4,1M}$ are constructed by using (annualized) 1- month Treasury yield. $r_{E,GGM,IBES1}$ is from the Gordon Growth Model using 1 year IBES earnings forecast. $r_{E,GGM,IBES5}$ is using 5-year IBES earnings forecast. $r_{E,GLS,IBES}$ is from Residual Income Model using IBES earnings forecast. $r_{E,GGM,HDZ1}$ is the same as $r_{E,GGM,IBES1}$ but using model predicted earnings. It is the same for $r_{E,GGM,HDZ5}$ and $r_{E,GLS,HDZ}$. Lev_{MKT} is market leverage;Lev_{WT} is $(Lev_{IND}+Lev_{MKT})/2$ where Lev_{IND} is the industry median leverage. Tax_{SIM} is the simulated tax rate. $r_{D,AV}$ is the average cost of debt. The construction details are in the Appendix. All variables are winsorized at 1% level each tail every year.

	CAPM,10Y	FF4,10Y	CAPM,1M	FF4,1M	GGM,HDZ5	GLS,HDZ	GGM,IBES1	GLS,IBES
Q	0.042***	0.044***	0.042***	0.044***	0.047***	0.049***	0.052***	0.049***
	(10.31)	(10.49)	(10.28)	(10.48)	(9.72)	(8.68)	(7.48)	(6.93)
$EBITDA/K$	0.012	0.011	0.012	0.011	0.015	0.017**	0.068***	0.019***
	(1.55)	(1.37)	(1.55)	(1.37)	(1.56)	(2.15)	(6.55)	(2.86)
Lev_{WT}	-0.052**	-0.054**	-0.052**	-0.054**	-0.011	-0.033	0.099***	0.003
	(-2.28)	(-2.39)	(-2.28)	(-2.39)	(-0.43)	(-1.49)	(2.80)	(0.11)
$r_{D,AV}$	-0.066***	-0.064***	-0.066***	-0.064***	-0.064***	-0.072***	-0.038***	-0.055***
	(-4.74)	(-4.61)	(-4.74)	(-4.61)	(-5.09)	(-4.61)	(-2.60)	(-4.40)
Tax_{SIM}	0.028**	0.016	0.027**	0.016	-0.050***	-0.015	-0.130***	-0.022
	(2.12)	(1.24)	(2.12)	(1.24)	(-3.87)	(-1.20)	(-6.66)	(-1.44)
r_E	0.243***	0.062***	0.243***	0.061***	-0.197***	-0.065***	-0.123***	0.026
	(5.79)	(3.66)	(5.80)	(3.58)	(-8.51)	(-2.99)	(-3.23)	(0.86)
[1em] Yr. and Ind.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	55123	55123	55123	55123	50407	45220	35885	29954
29954								
Adj. R^2	0.144	0.141	0.144	0.141	0.168	0.163	0.225	0.172

t statistics in parentheses

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

Table XII: WACC sorted by Financial Constraint Index

This table reports the one-way sort of WACC by different financial constraint indices . The firm level data is from the Compustat/CRSP merged data file. The sample period is from 1960 to 2010. We drop foreign companies, and the companies with a SIC code that is between 4900 and 4999, between 6000 and 6999, or greater 9000. We also drop the firms with total asset below 10 million dollars (in year 2004 dollars). The top row indicates which WACC we use, and the WACC is suppressed. $wacc_{CAPM,10Y} = r_{E,CAPM,10Y} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$, $wacc_{FF4,10Y} = r_{E,FF4,10Y} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$, $wacc_{GGM,HDZ5} = r_{E,GGM,HDZ5} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$, $wacc_{GLS,HDZ5} = r_{E,GLS,HDZ5} \times (1 - Lev_{WT}) + r_{D,AV} \times Lev_{WT} \times (1 - Tax_{Top})$. $r_{E,CAPM,10Y}$ is the cost of equity using CAPM model. $r_{E,FF4,10Y}$ is using Fama-French 3-factor and momentum factor. $r_{E,GGM,HDZ5}$ is from Gordon Growth Model using model predicted earnings. $r_{E,GLS,HDZ}$ is from Residual Income Model. Lev_{MKT} is market leverage; Lev_{WT} is $(Lev_{IND} + Lev_{MKT})/2$ where Lev_{IND} is the industry median leverage. Tax_{Top} is top tax rate in the corporation income tax brackets. $r_{D,AV}$ is the average cost of debt. The construction details are in the Appendix. All variables are winsorized at 1% level each tail every year. Following Hadlock and Pierce (2010), $SA\ index = -0.737 \times Size + 0.043 \times Size^2 - 0.040 \times Age$ where Size is the log of inflation adjusted (to 2004) book assets, and age is the number of years the firm has been on Compustat. In calculating this index, Size is replaced with log($4.5 billion) and age with thirty-seven years if the actual values exceed these thresholds. Following Lamont et al. (2001), $KZ\ index = -1.001909 \times [(Item18 + Item14)/Item8] + .2826389 \times Q + 3.139193 \times [(Item9 + Item34)/(Item9 + Item34 + Item216)] - 39.3678 \times [(Item21 + Item19)/Item8] - 1.314759 \times [Item1/Item8]$. Data Item 8 is lagged. Following Whited and Wu (2006), $WW\ index = 0.091 \times CF - 0.062 \times DIVPOS + 0.021 \times TLTD - 0.044 \times LNTA + 0.102 \times ISG - 0.035 \times SG$ where CF=[(Item 18 + Item 14)/ Item 8]; DIVPOS=1 if Item 127>0; TLTD=[(Item 9+Item 34) / (Item 9+Item 34 + Item 216)] ; LNTA=log(Item6); ISG is the firm's three-digit industry sales growth; SG is the firm's sales growth. Data item 8 is lagged. Item numbers refer to COMPUSTAT annual data items. In each year, we sort all firms in quintiles by certain financial constraint index. We report the mean and the median of WACC in each quintile over all sample period.

		CAPM,10Y		FF4,10Y		GGM,HDZ5		GLS,HDZ5	
KZ Index		mean	median	mean	median	mean	median	mean	median
Less Constrained	1	0.147	0.145	0.150	0.146	0.112	0.091	0.115	0.112
	2	0.142	0.141	0.152	0.149	0.110	0.090	0.107	0.105
	3	0.140	0.138	0.155	0.152	0.112	0.092	0.103	0.101
	4	0.136	0.133	0.156	0.152	0.114	0.093	0.101	0.097
More Constrained	5	0.135	0.132	0.151	0.148	0.122	0.101	0.109	0.100
WW Index		mean	median	mean	median	mean	median	mean	median
Less Constrained	1	0.134	0.134	0.138	0.136	0.083	0.074	0.093	0.094
	2	0.139	0.138	0.151	0.150	0.091	0.082	0.096	0.097
	3	0.141	0.139	0.156	0.154	0.107	0.096	0.103	0.104
	4	0.141	0.138	0.159	0.155	0.132	0.113	0.113	0.109
More Constrained	5	0.146	0.142	0.161	0.159	0.158	0.135	0.130	0.117
SA Index		mean	median	mean	median	mean	median	mean	median
Less Constrained	1	0.135	0.135	0.139	0.137	0.083	0.075	0.092	0.093
	2	0.139	0.138	0.151	0.148	0.089	0.080	0.094	0.096
	3	0.142	0.140	0.156	0.154	0.100	0.088	0.099	0.100
	4	0.143	0.140	0.160	0.157	0.124	0.110	0.108	0.108
More Constrained	5	0.145	0.140	0.160	0.158	0.177	0.162	0.142	0.136

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