Firms' Perceived Cost of Capital*

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Abstract

We study firms' perceptions of their cost of capital using hand-collected data covering 20 years. Firms correctly incorporate time variation in interest rates and risk premia as well as some cross-sectional factors into their perceived cost of capital, but they also make large mistakes. Only 20% of the variation in the perceived cost of capital reflects variation in true risk premia and interest rates, with the remaining 80% reflecting mistakes in firms' perceptions. These mistakes generate long-run misallocation of capital that lowers aggregate productivity by 10% in a benchmark model. Forcing all firms to apply the same cost of capital would lead to a better allocation of capital than current corporate practice. The mistakes in the cost of capital challenge standard models, in particular the production-based asset pricing paradigm, and lead us to reject the "Investment CAPM."

Keywords: cost of capital, misallocation, production-based asset pricing
JEL classification: G1, G10, G12, G31, G32, G40

1 Introduction

According to standard theory, firms should invest in all projects for which the expected return exceeds the cost of capital. In theory, this straightforward investment rule leaves little room for error. In practice, however, the investment rule is complicated by the fact that firms cannot directly observe their cost of capital. The cost of capital depends on the returns that financial investors expect to earn from holding a given firm's debt and equity (Modigliani and Miller 1958). Since estimating these expected returns is notoriously difficult, firms' perceptions about their own cost of capital may deviate substantially from their "true" cost of capital. Such mistakes would distort investment decisions, lead to misallocation of capital, and reduce aggregate output.

In this paper, we study hand-collected data on firms' perceptions of their cost of capital and document large mistakes in these perceptions. The mistakes are large enough to reduce total factor productivity by 10%. Current corporate practice is so far from optimal that forcing all firms to use the same cost of capital would improve the allocation of capital. The variation in the perceived cost of capital is at odds with production-based asset pricing and, more generally, conventional investment models.

A firm's perceived cost of capital is its true cost of capital plus an error term,

$$r^{\text{perc.}} = r^{\text{true}} + \upsilon, \tag{1}$$

where firms' true cost of capital, r^{true}, is the return that a marginal investor in financial markets would require for providing capital to the firm. This required return is determined by risk premia and interest rates in financial markets (see, e.g., Welch 2011). The error term, υ, captures mistakes made by managers when forming perceptions about their true cost of capital. These errors are assumed to be zero in virtually all existing work in economics, in part because the perceived cost of capital is not observed in publicly available data. We use novel data to document large errors and study their economic implications.

We measure firms' perceived cost of capital using data from corporate conference calls between firm managers, financial investors, and analysts (see, e.g., Hassan et al. 2019 for the use of conference call data in economics). During these calls, managers occasionally share their perceptions of their cost of debt, equity, and total capital. We collect the data through manual reading of call transcripts. They contain around 2,500 large firms from 2002 to 2022. The data are generally representative of the population

except for a skew towards large firms, which implies the firms in our data represent a large fraction of the total market capitalization of developed markets (more than 40%). The data can be merged with detailed measures of firm-level characteristics and other proxies for the firm-level cost of capital, allowing us to assess how well firms' perceived cost of capital corresponds to their true cost of capital in financial markets.

We first document stylized facts about how the perceived cost of capital fluctuates with the true cost of capital. In the cross-section of firms, the perceived cost of capital is related to a firm's market beta, market capitalization, and valuation ratio, which are the traditional risk factors that determine the cost of capital in the Fama and French (1993) model. The perceived cost of capital is also strongly related to leverage, not due to a risk premium effect, but because the tax benefits of debt mechanically affect the cost of capital. Going beyond the traditional factors, we summarize the total impact of risk factors on the cross section of the perceived cost of capital using a simple multivariate model. We find that firm age, reliance on external finance, and other measures of risk are associated with the perceived cost of capital. In the time series, firms largely incorporate time variation in the equity risk premium and interest rates correctly, as also shown in Gormsen and Huber (2023).

While firms correctly incorporate some traditional risk factors into their perceived cost of capital, the majority of variation in the perceived cost of capital is driven by mistakes. To illustrate the magnitude of these mistakes, we decompose the variation in the perceived cost of capital into the part that reflects variation in the true cost of capital and the part that reflects errors. Since the variation coming from errors should not exist under the standard view, we refer to this variation as "excess volatility" in the perceived cost of capital. We introduce two methods that allow us to quantify the amount of excess volatility in the perceived cost of capital: one method is based on ex-post realized returns in financial markets and the other is based on the "implied cost of capital." We find that around 80% of the variation in the perceived cost of capital represents excess volatility. Only 20% of the variation can be justified by variation in firms' true cost of capital.

The excess volatility in the perceived cost of capital is driven by perceptions about the cost of equity and not about the cost of debt. In fact, we find essentially no excess volatility in the perceived cost of debt, consistent with the cost of debt being relatively easy to estimate. On the other hand, we find substantial excess volatility in the perceived cost of equity, consistent with the cost of equity being a difficult

object to estimate. The excess volatility is apparent from summary statistics alone. The 10-90 percentile range in the perceived cost of equity is 8 percentage points. For comparison, it is rare to find firms that have an 8 percentage point difference in long-run expected returns ex ante. The value premium–a prominent example of cross-sectional variation in long-run stock returns–leads to a 10-90 spread in ten-year expected returns of just 1.5 percentage points among large firms. It is therefore not surprising that the variation in the true cost of equity is insufficient to justify the large cross-sectional variation in the perceived cost of equity (see, e.g., Daniel et al. 2020 for a discussion of long-run returns to risk factors).

We verify that the excess volatility is not driven by firms estimating the cost of capital using the CAPM, a model with known problems. Rather, the excess volatility is equally large in the part of the perceived cost of capital that is not spanned by the CAPM or other standard risk factors. We also verify that the results are not driven by measurement error in the perceived cost of capital. We do so using an instrumental variable approach and by analyzing the relation between the perceived cost of capital and returns to capital. Moreover, we can rule out that the data on firm perceptions are subject to general measurement error because we find no excess volatility in the perceived cost of debt.

The mistakes in the perceived cost of capital lead to misallocation of capital in standard models. Firms that underestimate their cost of capital invest too much and firms that overestimate the cost of capital invest too little, relative to the optimal allocation. We quantify the extent of misallocation using the framework of Hsieh and Klenow (2009). While the framework is very stylized, it provides a useful way to gauge the economic implications of mistakes made by firms. In the framework, the excess volatility in the perceived cost of capital translates directly into lower total factor productivity (TFP). According to the model, the observed excess volatility in the perceived cost of capital generates misallocation that lowers TFP by around 10%. The allocation of capital would be closer to optimal if all firms were forced to use the same cost of capital, rather than firms relying on their own perceptions (see also Krüger et al. 2015 and Giroud et al. 2022).

For the excess volatility to lead to misallocation, firms' perceived cost of capital must influence their investment decisions. This is indeed the case in all standard models and the idea is supported empirically. Gormsen and Huber (2023) show that firms' perceived cost of capital influences their required returns on new investments

(i.e., their discount rates) and ultimately their investment decisions. The paper also shows that this transmission of the cost of capital into investment is severely muted over the short to medium run, as shocks to firms' perceived cost of capital are transmitted into firms' discount rates only slowly and over several years. In the long run, the perceived cost of capital does shape the required and realized returns on investments. This impact manifests itself in a strong relation between firms' perceived cost of capital and their return on invested capital. Overall, we find that deviations between discount rates and the perceived cost of capital have limited impact on the estimates of long-run misallocation.

Our results challenge theories in which rational expectations about the cost of capital are important. One example is production-based asset pricing, which assumes that firms know risk premia, and by extension their cost of capital, perfectly. Based on this assumption, the models attempts to learn about the dynamics of risk premia implied by the investment behavior of firms. However, the large mistakes in firms' perceived cost of capital suggest that firms do not know risk premia perfectly, challenging the underlying idea. We discuss the promises and challenges posed by our results for the production-based asset pricing paradigm. Moreover, we show that the mistakes in the perceived cost of capital leads to a rejection of the "Investment-CAPM," a popular production-based model used to describe risk premia through the lens of rational behavior by firms.

One may wonder whether firms deliberately use a cost of capital that differs from the true cost of capital because they believe that capital markets are mispriced. It is, however, not clear that firms have a motive to do so. Firms that want to maximize current stock prices should use expected returns as their cost of capital for a marginal investment, irrespective of whether or not markets are mispriced (Nagel 2019). If firms instead want to maximize future stock prices, they may want to abstain from incorporating risk premia that they believe constitute temporary mispricing into their perceived cost of capital (Stein 1996). One could similarly argue that a Bayesian manager who is uncertain about true risk premia would not want to incorporate all risk premia fully into their cost of capital, along the arguments in Martin and Nagel (2022). While these two arguments above could lead firms to only partially incorporate risk premia in their perceived cost of capital, they would not lead to a large excess volatility in the perceived cost of capital. Our results on excess volatility are thus difficult to reconcile with rational behavior by managers.

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A related question is why the market for corporate control cannot undo the mistakes made by managers. If the mistakes lower stock prices, one may think that an arbitrageur could buy the firm, correct the cost of capital, and sell the firm at a profit. There are, however, limits to arbitrage in the market for corporate control (Shleifer and Vishny 1997). A takeover of one of the large corporations in our sample requires an investment in the order of hundreds of billions of dollars, which exposes the arbitrageur to large idiosyncratic risk that can make the trade infeasible. Moreover, building the large position necessary for obtaining corporate control pushes prices up, particularly if the arbitrageur is prevented from building the position slowly over time. If demand is sufficiently inelastic (Gabaix and Koijen 2021), the price pressure from the takeover may destroy the potential gains from correcting the cost of capital. In addition, attempts to change firms' estimates of their cost of capital without a takeover could be prevented by other investors and agents sharing the mistaken perceptions of managers. This argument is supported by a large literature documenting mistakes in investor perceptions of stock returns (Greenwood and Shleifer 2014, Nagel and Xu 2022) and by the fact that we rarely observe push-back from investors when managers share the perceived cost of capital on the conference calls.

Previous research on the perceived cost of capital relies on qualitative survey evidence about the methods used by firms to estimate their cost of capital. According to the seminal Duke CFO Survey, 80 percent of large firms apply the CAPM, but 70 percent additionally use multi-factor models and 40 percent use historical returns (Graham and Harvey 2001, Graham 2022). Other surveys find similar results (Jacobs and Shivdasani 2012, Mukhlynina and Nyborg 2016, Jagannathan et al. 2016). These findings leave open how exactly firms apply and combine different approaches, whether firms act "as if" certain factors mattered, and how quantitatively important different factors actually are. More generally, there is no evidence on the relation between expected returns and the perceived cost of capital as well as the implications for misallocation and macro-finance models.[1]

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[1]Previous work has studied the quantitative importance of one factor, the market beta, for firms' discount rates (i.e., required returns, or hurdle rates, and not the perceived cost of capital), finding mixed results (Poterba and Summers 1995, Jagannathan et al. 2016, Cho and Salarkia 2020).

2 Framework and Data

2.1 Framework

A firm's cost of capital is the return required by financial investors (i.e., holders of the firm's debt and equity) in exchange for providing capital to the firm. A new investment project only adds to the market value of the firm (which is determined by investors) if the expected return of the project exceeds this cost of the capital. As a result, the cost of capital plays a key role in firms' investment decisions, both in textbook theory and in corporate practice.

The cost of capital is usually expressed in terms of the weighted average cost of capital (WACC), which is the weighted average of the cost of equity and the cost of debt, accounting for tax benefits of debt:

$$r_{i,t}^{\text{capital}} = \omega_{i,t} \times (1 - \tau) \times r_{i,t}^{\text{debt}} + (1 - \omega_{i,t}) \times r_{i,t}^{\text{equity}}, \tag{2}$$

where $r_{i,t}^{\text{capital}}$ denotes the cost of capital of firm i at time t, ω is the percentage of debt finance (leverage), τ is the tax rate, and $r_{i,t}^{\text{debt}}$ and $r_{i,t}^{\text{equity}}$ are the cost of debt and equity.

A fundamental challenge is that a firm's cost of capital is not directly observed, even by the managers of the firm, and needs to be estimated. If the law of one price holds, the cost of capital can be calculated as the expected return in financial markets for an investment with a similar level of risk as the project under consideration. Because the cost of capital of the firm refers to a project with a riskiness that is representative of the overall firm, the firm's cost of capital is determined by the expected returns on a financial investment with similar risk as the overall firm.[2] The true cost of capital for the firm is therefore obtained by using the expected return on the firm's debt and equity as the firm's cost of debt and equity:

$$r_{i,t}^{\text{true}} = \omega_{i,t} \times (1 - \tau) \times \mu_{i,t}^{\text{debt}} + (1 - \omega_{i,t}) \times \mu_{i,t}^{\text{equity}}, \tag{3}$$

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[2]In theory, firms should use a project-specific cost of capital when evaluating investment decisions. In practice, however, most firms calculate one cost of capital for the entire firm based on their existing debt and equity and then set required returns to investment, called discount rates or hurdle rates, that may deviate from the cost of capital and may be project-specific (Graham and Harvey 2001). In the cases where firms discuss project-specific cost of capital, we collect the numbers separately as a project-specific cost of capital (and do not use them in our analysis).

where $\mu_{i,t}^{\text{equity}}$ is the expected long-run return on the firm's equity and $\mu_{i,t}^{\text{debt}}$ is the expected return on the firm's debt (including all sources of debt). The literature usually models these expected returns as following a model of the form

$$\mu_{i,t} = \lambda^0 + \sum_k \lambda^k X_{i,t}^k, \tag{4}$$

where a factor or characteristic X^k commands a specific risk premium λ^k (e.g., Fama and French 1996, 2016).

Throughout much of the paper, we are interested in understanding how the perceived cost of capital deviates from the benchmark above. To this end, we write the perceived cost of capital of firm i as

$$r_{i,t}^{\text{perc.}} = r_{i,t}^{\text{true}} + \upsilon_{i,t}, \tag{5}$$

where $\upsilon_{i,t}$ reflects mistakes in the perceived cost of capital relative to the standard definition. The mistakes may arise if firms use incorrect estimates of the expected returns on debt and equity when forming their perceptions about their cost of capital. Such mistakes are plausible because estimating expected returns is notoriously difficult (Fama and French 1997, Pástor and Stambaugh 1999) and given that many agents are known to have biased beliefs about expected returns (Greenwood and Shleifer 2014, Giglio et al. 2021, Engelberg et al. 2020, Nagel and Xu 2022).

The rule for determining the true cost of capital does not depend on market efficiency. As long as the law of one price holds, and firms want to maximize their stock price, firms should use the expected returns on its debt and equity as its cost of debt and equity (Nagel 2019). To see this, note that a firm maximizes its stock price by maximizing the expected product of its future cash flows and the stochastic discount factor. This stochastic discount factor may represent "mispricing" or be driven by "behavioral" factors, leading stock markets to be inefficiently priced (Kozak et al. 2018). But as long as the stochastic discount factor exists, firms maximize stock prices in the standard way. Such maximization based on the stochastic discount factor leads to a similar rule for the cost of capital as the one described above (see Appendix B).

If firms attempt to maximize future stock prices rather than stock prices today, the rule for determining the true cost of capital may change slightly. In this case,

firms should use the expected future stochastic discount factor when making their investment decisions. In practice, doing so would imply that firms should use not incorporate transitory variation in expected returns in their true cost of capital. If, for instance, the expected return on the firm is temporarily elevated due to behavioral mispricing, the firm will want to leave out this variation from its true cost of capital (Stein 1996). Such behavior can explain why firms may not want to fully incorporate certain risk factors, such as the value factor, but it cannot explain the large excess volatility that we document in this paper.

2.2 Data Collection

Our analysis uses a new dataset of firm-level perceived cost of capital, merged to firm-level asset prices and firm-level exposure to risk factors.

Two challenges make it difficult to measure firms' perceived cost of capital. First, firms do not typically report a perceived cost of capital in official financial reports. Second, data from surveys are mostly anonymized and cannot easily be matched to firm characteristics, asset prices, and factor exposure. We overcome these challenges by relying on data from corporate earnings calls, investor conferences, and similar events, which we jointly call "conference calls." We build on the data collection procedure established in Gormsen and Huber (2023) and describe details in Appendix C.

Most listed firms hold quarterly conference calls to inform analysts and investors about their corporate strategy. Firm managers often explicitly disclose an internal estimate of their cost of capital on these calls, which we term the perceived cost of capital. The calls are relatively high-stakes settings, so managers have incentives to report accurate information if that information can be challenged by analysts and investors (Hassan et al. 2019). For example, statements from conference calls often appear as evidence in securities lawsuits (Rogers et al. 2011), analysts and investors ask managers detailed questions about how past realized investment decisions relate to their cost of capital, and within-firm changes in corporate discount rates reported on these calls predict changes in future investment (Gormsen and Huber 2023).

We search through all transcripts of calls available on the databases Refinitiv and FactSet for the years 2002 to 2022. We download paragraphs where managers mention at least one of 22 keywords.[3] Together with a team of research assistants, we

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[3]The keywords include capital asset pricing model, cost of capital, cost of debt, cost of equity,

manually read through the roughly 110,000 downloaded paragraphs and collect all instances where firms state the "cost of capital," the "weighted average cost of capital," or the "WACC" for the whole firm. The collected data do not include instances where firms discuss hypothetical values (e.g., "imagine a cost of capital of x percent"), where outsiders posit a cost of capital or ask suggestive question (e.g., "am I correctly assuming that your cost of capital is x percent?"), or where managers discuss rates associated with specific debt issuances (e.g., "the yield associated with the new bond issuance is x percent.") Firms almost always discuss the after-tax cost of capital, but we convert the few pre-tax values to after-tax values.

In addition to the perceived cost of capital, we also collect firms' perceived cost of debt, perceived cost of equity, and the discount rates used by firms to assess the net present value of new investment projects. To identify discount rates, we rely on explicit manager statements about the minimum required IRR that they want to earn on new investment projects.[4]

We link firm names from the conference call data to a Compustat firm key using manual matching of firm names. This allows us to then merge firm-level asset prices from the Center for Research in Security Prices and firm-level exposure to 153 equity factors, assembled by Jensen et al. (2023).

2.3 Summary Statistics

The mean perceived cost of capital is 8.6 percent, with substantial variation ranging from 5.3 at the 5th percentile to 12 percent at the 95th percentile, as shown in Table 1. The mean average discount rate, used internally by the firm to evaluate investment projects, is 15.3 percent.

We compare firms in the sample to the population of listed firms by reporting the average percentile of firms in the sample, relative to the population of firms in Compustat in the same year and country. The average CAPM beta, investment rate, book-to-market ratio, and profitability are relatively close to the 50th percentile,

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discount rate, expect a return, expected rate of return, expected return, fudge factor, hurdle rate, internal rate of return, opportunity cost of capital, require a return, required rate of return, required return, return on assets, return on invested capital, return on net assets, weighted average cost of capital, weighted cost of capital. We also include abbreviated keywords, for example, WACC.

[4]Other rates (such as realized and expected IRR) and ratios (such as required, realized, and expected ROA, ROIC, ROE) were separately recorded during the data collection to ensure that the perceived cost of capital and discount rate were clearly differentiated.

indicating that the average firm in the sample is similar to the average Compustat firm along these characteristics. The average firm in the sample is more levered compared to its year-country peer group, although the difference is relatively small (61st average percentile).

The main difference between firms in the sample and the Compustat population is that firms in the sample are distinctly larger, as the market value of the average firm in the sample lies at the 85th percentile. The skew toward larger firms implies that we cover a substantial share of aggregate market value. For instance, firms appearing in the sample at least once cover over 40 percent of total market value in advanced economies. The sample includes many well-known firms, such as AT&T, Bank of America, Disney, Exxon, Home Depot, Intel, JPMorgan Chase, Mastercard, Nestle, Novartis, UnitedHealth, and Visa. We refer to Gormsen and Huber (2023) for detailed analysis of the representativeness of the data.

3 Stylized Drivers of the Perceived Cost of Capital

We start the empirical analysis by presenting stylized facts on time variation and cross-sectional variation in the perceived cost of capital. We show that firms correctly incorporate time variation and some traditional asset pricing factors into their perceived cost of capital. We then construct a parsimonious empirical model that summarizes the behavior of the perceived cost of capital.

3.1 Time Variation in the Perceived Cost of Capital

Our sample for the perceived cost of capital runs from 2002 to 2022. Over this period, there have been substantial fluctuations in expected returns in financial markets. We have seen a secular downward trend in expected returns in both equity and debt markets, with fluctuations around the financial crisis, the sovereign debt crisis, and the 2022 inflation spike.

Gormsen and Huber (2023) document that firms have generally incorporated this time variation in financial market prices into their perceived cost of capital. To illustrate this relation, Table 2 presents regressions of firms' perceived cost of capital on measures of the financial cost of capital. For simplicity, we use the earnings yield plus expected inflation as a proxy for time variation in the cost of equity and the

long-term government interest rate as a proxy for time variation in the cost of debt (this approach abstracts from the impact of credit risk).

In column (1) of Table 2, we regress the firm-level perceived cost of capital on the country-level earnings yield and interest rate for U.S. firms. The slope coefficients are 0.51 and 0.27. Firms are, on average, financed with $2/3$ equity and $1/3$ debt, so if the proxies capture the cost of equity and debt perfectly, we should expect slopes of $2/3$ on the equity yield and $1/3 \times$ the tax rate on the interest rate. However, fluctuations in the earnings yield ($+$ expected inflation) are not a pure measure of the cost of capital on financial markets, as they also reflect fluctuations in expected real growth rates, which would lead to lower slopes. For instance, if one believes that 80% of the fluctuations in the earnings yield represent discount rates and 20% represent growth rates (and the two are orthogonal), we should expect a slope coefficient of $0.8 \times 2/3 = 0.53$ (see, e.g., Campbell 1996 for a discussion of such variance decompositions). The estimated slope coefficients are therefore close to what one would expect if firms perfectly incorporated fluctuations in expected financial returns into their perceived cost of capital.

The results from column (1) are visualized in Figure 1. The left panel plots the average perceived cost of capital by year for U.S. firms along with the U.S. earnings yield (the inverse of the CAPE) $+$ expected inflation. The figure shows a downward trend in the perceived cost of capital that moves almost one-to-one with the trend in the earnings yield (the earnings yield is on a separate y-axis, but the ranges of the two y-axes are the same). We observe a similarly close relation between the average perceived cost of debt in the U.S. and the long-term Treasury rate in the right panel. While the trends comove almost one-to-one, the cost of debt is higher than the Treasury rate due to credit risk.

In column (2) of Table 2, we find similar results including firm fixed effects. This finding shows that the relation between the cost of capital and the financial expected returns is driven by firms updating their perceived cost of capital over time. In column (3), we find similar results in the global sample, where we continue to use the earnings yield for a given country and the government long-term interest rate in a given country on the right-hand side.

Overall, the results suggests that firms, on average, incorporate long-run fluctuations in expected stock returns and interest rates into their perceived cost of capital. But while the slope coefficients are close to what full incorporation would predict, the R^2 is far from one, suggesting substantial heterogeneity across firms. We will study

this cross-sectional variation in the upcoming section.

The finding that firms appear to incorporate fluctuations in expected stock returns into their perceived cost of capital may be surprising, given the syllabuses of MBA classes. Most MBA programs teach simplified methods for estimating the cost of equity and not how to incorporate time variation in expected stock returns. In his AFA Presidential Address, Cochrane (2011) notes that students are typically taught to use a 6% market risk premium and that "it is interesting that investment decisions get so close to right anyway." He speculates that perhaps "a generation of our MBAs figured out how to jigger the numbers and get the right answer" (page 1087 of Cochrane 2011). Our results suggest that managers explicitly incorporate time-varying risk premia in line with standard models of expected returns.

3.2 Traditional Cross-Sectional Drivers

In this section, we provide an initial analysis of the cross-section of the perceived cost of capital. We highlight to what extent firms incorporate some of the classic drivers of expected returns into their perceived cost of capital. Our analysis is motivated by the seminal theories of Modigliani and Miller (1958) and Sharpe (1964) along with the empirical results of Fama and French (1993). According to Modigliani and Miller, firms with higher leverage should have lower cost of capital due to a higher tax shield (see equation 2). According to Fama and French, cross-sectional variation in the cost of equity–and therefore to some extent the cost of capital–should be determined by exposure to the market, size, and value factors (see equation 4).

Figure 2 illustrates the empirical relevance of leverage, market beta, size, and value for cross-sectional variation in the perceived cost of capital. In the top-left panel, we plot the perceived cost of capital for five different groups based on leverage ratios. The perceived cost of capital is around 9.5% for firms with the lowest leverage and 8.5% for firms with the highest leverage. The magnitude of this drop is consistent with the benefits of the tax shield. To see this, note that leverage increases from around 0.1 to 0.6 when going from the bottom to top group. If we assume a tax rate of 20% and a cost of debt of around 4.66% (the average in our sample), the difference in the tax shield should be around $0.6 \times 0.2 \times 4.66\% = 0.56\%$.

The top-right panel in Figure 2 plots the average perceived cost of capital for 5 groups of firms sorted on the CAPM beta. The perceived cost of capital goes from

around 8% to just under 9.5%. This finding is hardly surprising given that firms in surveys report using the CAPM model as one input into their perceived cost of capital (see, e.g., Graham and Harvey 2001).

The bottom two panels of Figure 2 consider the remaining characteristics, size and value. The left panel reveals a substantial size effect. When going from nano-cap firms to mega-cap firms, the perceived cost of capital drops by almost 3 percentage points, from slightly above 11% to slightly above 8%. The result may be more surprising than the beta result, as managers do not explicitly account for size premia according to the survey by Graham and Harvey (2001). The result is, however, consistent with the fact that some financial analytics firms, like the Kroll Cost of Capital Navigator by Duff and Phelps, account for size premia.[5]

Finally, the bottom-right panel plots the perceived cost of capital for firms sorted by value (book-to-market ratios). The perceived cost of capital increases slightly when going from the firms with the lowest book-to-market (growth firms) to firms with the highest book-to-market (value firms). This result is qualitatively consistent with the value premium documented by Fama and French (1992). However, the magnitude is small (the range on the y-axis is much shorter than for the other plots). Going from growth to value firms only increases the perceived cost of capital by around 20 basis points.

We also study the above characteristics in multivariate panel regressions in the Online Appendix. The multivariate relationships between the perceived cost of capital and the variables in Figure 2 are similar to the univariate relationships. Cost of capital increases in market betas and decreases in size and leverage. These results are highly significant. For value, however, the effect is more modest. In general, the perceived cost of capital is higher for value firms, but the effect tends to be statistically insignificant. See Table A1 and Section Appendix D.2 in the Online Appendix.

Another salient driver of cross-sectional variation in the perceived cost of capital is the "greenness" of the underlying firm. Gormsen et al. (2023) studies how firms' perceived cost of capital relates to the greenness of the firm, as measured by the MSCI. That paper finds that green and brown firms historically have had similar perceived cost of capital, but that the cost of capital between the two has diverged substantially since the rise of the sustainable investment movement. At the end of the 2020s, the greenest half of the firms reported a perceived cost of capital that was 1 percentage

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[5]See https://www.kroll.com/en/cost-of-capital/frequently-asked-questions.

point below the brown counterpart. We do not analyze greenness in this paper as it is not part of the classical risk factors in the dataset of Jensen et al. (2023).

3.3   An Empirical Model of Cross-Sectional Variation in the Perceived Cost of Capital

We end the analysis on stylized facts by producing a parsimonious empirical model to describe the variation in the perceived cost of capital. Following the discussion in Section 2.1, we model firms' perceived cost of capital as a function of exposure to equity risk factors. We select the empirically relevant risk factors for the perceived cost of capital using a Lasso model.

Our analysis is based on the 153 risk factors identified by Jensen et al. (2023). The authors share data that contain firm-level exposure to the to 153 risk factors. The exposure to each risk factor is measured through firm-level characteristics (a high book-to-market ratio, for instance, reflects a high exposure to the value factor). The characteristics are all measured in cross-sectional percentiles of the given country at the given date. We use a Lasso procedure to pick the combination of characteristics that best describe the perceived cost of capital. In addition to the 153 characteristics that proxy for exposure to risk factors, we also allow the model to pick dummy variables for the currency used by a firm.

The Lasso procedure selects 11 characteristics. Figure 3 plots the loadings of the perceived cost of capital on each of these characteristics. The loadings tell us how much the perceived cost of capital increases when a firm goes from the bottom to the top of the cross-sectional distribution of the given characteristic, keeping the other characteristics constant. For instance, the loading on the CAPM beta is around 2, which means the perceived cost of capital is 2 percentage points higher for firms with the highest market beta than for firms with the lowest market beta.

The Lasso procedure also pick leverage and size characteristics, consistent with the analysis in Section 2. There are three leverage related variables, namely the debt-to-market value of the firm, the net debt-to-price of the firm, and the assets to book equity. All of these are associated with a lower perceived cost of capital, consistent with Figure 2. Market size also shows up with the expected, negative sign. There is no direct value characteristic, consistent with the modest effect shown in Figure 2. However, when we use the Lasso model to calculate predicted values of

the perceived cost of capital, those predicted values are positively associated with book-to-market ratios, suggesting that the other variables in combination capture a value effect. The lasso procedure also picks the firm's age, access to external finance, and idiosyncratic volatility, among others, as relevant risk factors.

We use the Lasso model above to construct a database of predicted values for the perceived cost of capital. By using the Lasso model, we can construct predicted values for firm/quarters where we do not observe the perceived cost of capital. The resulting database contains 250,000 firm-quarter observations of predicted values. We share the resulting data on costofcapital.org. We explain the exact details of our methodology in Section Appendix G in the Online Appendix, which also includes a description of a related methodology for firms' discount rates.

4 Excess Volatility in the Perceived Cost of Capital

The previous section documents that firms' perceived cost of capital is related to risk premia and interest rates in financial markets, as predicted by theory. In this section, we test whether the perceived cost of capital is, in fact, equal to cost of capital implied by risk premia and interest rates. We find that it is not: firms' perceived cost of capital is excessively volatile relative to what can be justified by variation in risk premia and interest rates in financial markets.

4.1 Motivating Evidence from Summary Statistics

We begin with simple summary statistics indicating that the perceived cost of capital is likely excessively volatile. Figure 4 plots histograms of the perceived cost of capital and equity. The 10-90 percentile range in the perceived cost of equity is 8 percentage points. This is well beyond the usual spread observed in long-expected returns across firms. Consider, for instance, the value premium documented by Fama and French (1992). Among large firms, value firms have 3.5% higher one-year stock returns than growth firms (with growth and value measures as the 10th and 90th percentile of book-to-market ratio). If one extends the horizon to 10-year returns, which is the relevant horizon for the cost of capital, the return difference decreases to around 1.5% (although standard errors are wide). Given this comparison, it is plausible that much of the volatility in the perceived cost of capital cannot be justified by true variation

in expected returns. The upcoming sections studies this possibility formally.

4.2 Variance Decomposition Framework

We formalize the analysis through a variance decomposition. Recall from Section 2.1 that the perceived cost of capital is

$$r_{i,t}^{\text{perc.}} = r_{i,t}^{\text{true}} + \upsilon_{i,t}, \tag{6}$$

where $r_{i,t}^{\text{true.}}$ is the true cost of capital, as defined in equation (3) of Section 2.1, and $\upsilon_{i,t}$ reflects mistakes relative to the standard definition. The equation gives rise to the variance decomposition

$$\text{var}\left(r_{i,t}^{\text{perc.}}\right) = \underbrace{\text{cov}\left(r_{i,t}^{\text{perc.}}, r_{i,t}^{\text{true}}\right)}_{\text{true variation}} + \underbrace{\text{cov}\left(r_{i,t}^{\text{perc.}}, \upsilon_{i,t}\right)}_{\text{excess variation}}. \tag{7}$$

The first term on the right hand side of (7) reflects the part of the variation in the perceived cost of capital that is justified by variation in the true cost of capital, i.e., variation in expected future returns on debt and equity. The second term reflects the part of the variation that is not justified by variation in the true cost of capital. We refer to this variation as "excess variation." This term captures variation in the perceived cost of capital that should not exist according to standard models. The term is related to the "excess volatility" documented by Shiller (1981), although our excess volatility differs conceptually from his: Shiller document excess volatility in stock prices, which can be rationalized by movements in risk premia, whereas we document excess volatility in what is effectively an expectation, which cannot be rationalized through risk premia.

Dividing both sides of (7) by the variance of the perceived cost of capital yields

$$1 = \underbrace{\frac{\text{cov}\left(r_{i,t}^{\text{true}}, r_{i,t}^{\text{perc.}}\right)}{\text{var}\left(r_{i,t}^{\text{perc.}}\right)}}_{\gamma^{\text{true}}} + \underbrace{\frac{\text{cov}\left(\upsilon_{i,t}, r_{i,t}^{\text{perc.}}\right)}{\text{var}\left(r_{i,t}^{\text{perc.}}\right)}}_{\gamma^{\text{excess}}}, \tag{8}$$

where γ^{true} and $\gamma^{\text{excessive}}$ denote the fraction of the total variance in the perceived cost of capital that reflects true and excessive variation, respectively. These fractions can be recovered as slope coefficients in regressions that have the perceived cost of capital

on the right-hand side and either the true cost of capital or the error in the perceived cost of capital on the left-hand side. The challenge in estimating γ^{true} and γ^{excess} is that we do not directly observe the true cost of capital. We will recover the slope coefficients in two different ways. In Section 4.3, we use realized returns to capture variation in the true cost of capital and in Section 4.4 we use "the implied cost of capital" to capture variation in the true cost of capital.

4.3 Excess Volatility Relative to Realized Returns

In this section, we estimate the amount of excess volatility using ex post realized returns. Recall from equation (2) that the perceived cost of capital is

$$r_{i,t}^{\text{capital}} = \omega_{i,t} \times (1 - \tau) \times r_{i,t}^{\text{debt}} + (1 - \omega_{i,t}) \times r_{i,t}^{\text{equity}}, \tag{9}$$

where we do not directly observe the cost of debt and equity. The cost of equity is particularly complicated to estimate. Fortunately, we can implement the variance decomposition without observing expected returns. Assume for now that we can observe the cost of debt, but not the cost of equity. We define the realized return on equity as $R_{i,t+j}^{\text{equity}} = \mu_{i,t}^{\text{equity}} + e_{i,t+j}$, where $R_{i,t+j}$ is the realized return between period t and $t + j$ on stock i, $\mu_{i,t}^{\text{equity}} = E_t[R_{i,t+j}^{\text{equity}}]$ is the expected return at time t, and $e_{i,t+j}$ is the unexpected shock. We define a new variable, $r_{i,t+j}^{\text{realized}}$, in which we replace the cost of equity with the realized returns:

$$r_{i,t+j}^{\text{realized}} = \omega_{i,t} \times (1 - \tau) \times r_{i,t}^{\text{debt}} + (1 - \omega_{i,t}) \times R_{i,t+j}^{\text{equity}} \tag{10}$$

$$= r_{i,t}^{\text{true}} - (1 - \omega_{i,t}) \times e_{i,t+j}. \tag{11}$$

We can now estimate γ^{excess} based on $r_{i,t+j}^{\text{realized}}$ as

$$\frac{\text{cov}\left(r_{i,t}^{\text{perc.}} - r_{i,t+j}^{\text{realized}}, r_{i,t}^{\text{perc.}}\right)}{\text{var}\left(r_{i,t}^{\text{perc.}}\right)} = \frac{\text{cov}\left(v_{i,t+j}^{\text{realized}}, r_{i,t}^{\text{perc.}}\right)}{\text{var}\left(r_{i,t}^{\text{perc.}}\right)} = \gamma^{\text{excess}}. \tag{12}$$

This methodology works because the realization of the unexpected shock by definition cannot comove with the ex ante perceived cost of capital, so the slope coefficient will only reflect the comovement between the perceived cost of capital and the expected part of the realized returns.

To implement the above approach, we need to calculate realized returns over a

horizon at which the expected return is a meaningful proxy for the cost of equity. In principle, the cost of equity is the expected return over the very long horizon, with "very long" often considered to be 10-years or more. To ensure a sufficient number of observations, we will calculate realized returns over a 5-year horizon. If expected returns are constant over time, the horizon is irrelevant. If expected returns mean-revert over time, as is often assumed, using too short time horizons results in downwards biased slope coefficients in equation (12). Our choice of horizon is thus conservative in that it may overestimate γ^{true} and underestimate γ^{excess}.

For the cost of debt, one could in principle apply a similar approach as for the cost of equity. However, for debt, which refers to both bank and bond debt, it is easier to calculate expected returns than to calculate realized returns. We follow Gormsen and Huber (2023) and use interest expenses (including coupon payments on bonds) over total debt to proxy for the cost of debt. We measure both variables using Compustat data. While this measure is a simplified measure of the true cost of debt, neglecting, among other things, default risk, it likely captures much of the true variation in cost of debt. We verify later that our measure, in fact, captures most of the relevant variation in the perceived cost of debt and that the excess volatility that we uncover does not arise from our measurement of the true cost of debt.

Panel A of Table 3 presents estimates of γ^{excess}. In the first column, we regress the "realized error," $r_{i,t}^{\text{capital}} - r_{i,t+j}^{\text{realized}}$, onto the perceived cost of capital of the same firm in the same quarter without any fixed effects. The estimate is 0.73, implying that 73% of the total variation in the perceived cost of capital reflects excess variation. Accordingly, only 27% of the variation reflects variation in the true cost of capital. When adding country and year fixed effects, the slope coefficients increase further to 0.95.

The estimates in Panel A of Table 3 have large standard errors given the high ratio of noise-to-signal inherent in realized returns (see, e.g., Fama and French 1988). While we can strongly reject the hypothesis that there is no excess variation, we cannot reject the hypothesis that there is no true variation (i.e., that the slope is equal to 1). In the upcoming section 4.4, we will pursue an alternative approach with more power that allows us to reject the hypothesis that there is no true variation.

One may be concerned that the realized returns over our sample are not representative of true ex ante expectations. It is, for instance, well known that the size and value effects have been much weaker after 2000 than before. The relation between

18

beta and expected returns has also been particularly weak since 2000. To the extent that firms incorporate beta, size, and value in their expectations, these trends may explain why the perceived cost of capital has been mostly wrong when comparing to realized returns. To address this concern, columns (4)-(6) of Panel A control for firm-level exposure to the beta, size, and value factors. The slope coefficients fall slightly to 0.68 and 0.85, but the qualitative conclusions remain unchanged.

4.4   Excess Volatility Relative to the Implied Cost of Capital

In this section, we estimate excess volatility using an approach based on "the implied cost of capital." This approach has more statistical power than the one in the previous section, but requires additional assumptions.

The implied cost of capital calculates the expected long-run stock return for a given firm as implied by current valuations and expectations among investors. The implied cost of capital is known to be a noisy predictor of true expected returns (Lee et al. 2021). In a global sample of stock returns of 4,500 firms between 1976 and 2021, we find that our implied cost of capital measure predicts future returns with a slope coefficient of 0.60 (p-value of 0.00). The measure is thus a useful predictor of future returns, but 40% of the variation in the implied cost of capital is noise that is not justified by future expected returns. Assuming that the implied cost of capital is equal to true expected returns plus noise that is uncorrelated with firms' perceptions, we can use the implied cost of capital to uncover the true amount of excess volatility in the perceived cost of capital.

Following Mohanram and Gode (2013), we use the average of four different measures of the implied cost of capital. Details on the measures and their construction is in Appendix F. The implied cost of capital captures only the implied cost of equity, so we use the same methodology for the cost of debt, leverage, and taxes as in the previous section.

Panel B in Table 3 reports estimates of γ^{excess} based on the implied cost of capital method. The slope coefficient in the leftmost column is 0.83, implying that 83% of the variation in the perceived cost of capital represents excess volatility and that only 17% reflects variation in the true cost of capital. Adding country and year fixed effects increases the fraction of excess volatility slightly. The estimates are all close to their counterparts based on realized returns in Panel A. The standard errors are

substantially smaller than for realized returns, which is expected, as the implied cost of capital is an expected return, which is much less volatile than a realized return. We can now reject the hypothesis that none of the variation in the perceived cost of capital reflect variation in the true cost of capital (i.e., we reject a slope coefficient of 1).

The excess volatility in the perceived cost of capital must reflect excess volatility in the perceived cost of debt or equity. Since we have data on both, we estimate excess volatility in each separately by projecting the error in the perceived cost of equity onto the perceived cost of equity and the error in the perceived cost of debt onto the perceived cost of debt. The errors for the perceived cost of equity are based on the implied cost of capital, whereas the errors for the perceived cost of debt are based on the interest rate expense measure described in Section 4.3.

Figure 5 shows that the excess volatility in the perceived cost of equity is around 80%, similar to the amount of excess volatility in the perceived cost of capital. In contrast, the excess volatility in the perceived cost of debt is only 13%. The excess volatility in the perceived cost of capital is thus driven by the perceptions about the cost of equity rather than the cost of debt. This finding may reflect the fact that the cost of debt is substantially easier to estimate than the cost of equity, leaving little room for error when managers form their perceptions. Conceptually, most of the variation in the perceived cost of capital comes from the perceived cost of equity, because the perceived cost of equity is much more volatile than the perceived cost of debt (see Table 1) and because firms are mostly financed with equity. Consistent with this argument, the excess volatility in the perceived cost of capital is close to the excess volatility in the perceived cost of equity.

The perceived cost of capital can be decomposed into a part that reflects exposure to underlying risk factors and a part that reflects idiosyncratic perceptions of firms. It is theoretically possible that the excess volatility comes entirely from the idiosyncratic perceptions and that the part coming form risk factors does not contain excess volatility. To test this possibility, we use the predicted value of the perceived cost of capital from Section 3.3 as an instrument in a two-stage least square regression. We first project the perceived cost of capital onto the predicted value in a first stage, and then project our measure of the true cost of capital onto the estimates from the first stage.

The results of the two-stage least square regressions are in columns (4)-(6) of Panel B in Table 3. The excess volatility in the predicted part of the perceived cost of

20

capital is around 50%, depending on the exact specification. These results show that there is substantial excess volatility even in the part of the perceived cost of capital that is driven by risk factors.

4.5   Measurement Error Concerns

One may be concerned that the estimates of excess volatility are driven by measurement error. If the perceived cost of capital that we measure on conference calls contains error, our results would overstate the amount of excess volatility. However, we argue that there is unlikely to be a substantial amount of measurement error. For one, managers are unlikely to state wrong numbers on conference calls as the cost of capital is a well-defined construct they are expected to know. Moreover, we collect the data manually and examine all records multiple times, minimizing the risk that numbers are saved incorrectly. We also record potential project-specific cost of capital estimates separately from the firm-level cost of capital that our analysis is based on, making measurement error from confusing project-specific and firm-level perceptions unlikely (discussions of project-specific cost of capital are very rare, as explained in Section 2.2).

The clearest evidence against measurement error is the fact that we find almost no excess volatility in the perceived cost of debt. If the excess volatility mechanically reflected measurement error, we would find excess volatility in both the perceived cost of debt and equity. As a result, measurement error can only affect our excess volatility estimates if the error were only in the perceived cost of equity and capital, but not in the cost of debt. Given that we record them using identical procedures, it is not clear how such specific measurement error could arise.

Another argument against measurement error driving the results can be found in columns (4)-(6) of Panel B in Table 3. We find excess volatility in the part of the perceived cost of capital that is driven by exposure to risk factors. Since this part is predicted using a two-stage procedure, the results in columns (4)-(6) cannot be driven by classical measurement error. This argument does not imply that we consider the other part, which is not driven by risk factor exposure, as containing measurement error. We are merely pointing out that the two-stage procedure ensures that the part driven by risk factor exposure cannot contain error.

5 Capital Misallocation due to Mistakes in the Perceived Cost of Capital

In this section, we analyze how excess volatility in the perceived cost of capital generates capital misallocation that lowers total factor productivity. We quantify the productivity loss using the framework of Hsieh and Klenow (2009). The punchline is that excess volatility in the perceived cost of capital decreases total factor productivity by around 10%.

In order for the excess volatility to lead to misallocation, the perceived cost of capital must influence firms' allocation of capital. Gormsen and Huber (2023) show that changes in firms' perceived cost of capital are associated with changes in their required return on new investment and ultimately their capital allocation decisions. However, firms' perceived cost of capital is generally not transmitted into capital allocation decisions as seamlessly as assumed in standard theory. In Section 5.3, we discuss how such deviations from the standard models influence our results.

5.1 Model of Misallocation

We build on the framework of Hsieh and Klenow (2009).

Assumptions The model features monopolistic competition between heterogeneous firms. Firms produce differentiated products that are combined into sector outputs, which in turn are combined into a final good. The final good is produced by a representative firm without market power and given by

$$Y = \prod_{s=1}^{S} Y_s^{\theta_s},$$

where Y_s is the output of sector s and the sector-level output elasticities θ_s sum to one.

The output of sector s is a CES aggregate of the output Y_{si} produced by firms $i = 1, .., M_s$ in the sector,

$$Y_s = \left(\sum_{i=1}^{M_s} Y_{si}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}},$$

with σ denoting the elasticity of substitution of products in the sector. Each firm produces output using a Cobb-Douglas function,

$$Y_{si} = A_{si} K_{si}^{\alpha_s} L_{si}^{1-\alpha_s},$$

where A_{si} is the total factor productivity of firm i in sector s, K_{si} and L_{si} are capital and labor of firm i in sector s, and α_s is the output elasticity of capital in sector s.

Firms face a perceived cost of capital $r_{si} = (1 + \tau_{si}) \times r_{si}^{\text{true}}$, where r_{si}^{true} is the true financial cost of capital and τ_{si} captures distortions to the perceived cost of capital. We assume that τ_{si} is independent of r_{si}^{true} and that total factor productivity and the perceived cost of capital are jointly log-normally distributed. All firms pay the same wage w for labor.[6] Total capital and labor are in fixed supply, and P, P_s, and P_{si} denote the product prices of the final, sector, and firm-level output, respectively.

Solution   Total output is

$$Y = \prod_{s=1}^{S} \left(\text{TFP}_s K_s^{\alpha_s} L_s^{1-\alpha_s} \right)^{\theta_s}, \tag{13}$$

where L_s and K_s are labor and capital employed in sector s and

$$\text{TFP}_s = \left[\sum_{i=1}^{M_s} \left(A_{si} \frac{\overline{\text{TFPR}_s}}{\text{TFPR}_{si}} \right)^{\sigma-1} \right]^{\frac{1}{\sigma_1}} \tag{14}$$

is the total factor productivity of sector s. TFPR_{si} is the firm-level total factor revenue productivity, defined as the firm-level total factor productivity A_{si} times the price of the product produced by the firm, P_{si}. TFPR_{si} can also be expressed as

$$\text{TFPR}_{si} = (r_{si})^{\alpha_s} \frac{1}{1-\alpha_s} \left(\frac{1-\alpha_s}{\alpha_s} \right)^{\alpha_s}. \tag{15}$$

$\overline{\text{TFPR}_s}$ is the geometric average of TFPR across firms in sector s. Absent mistakes in the perceived cost of capital, variation in TFPR within a sector is pinned down

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[6]The assumption of constant wages is introduced for simplicity but can be relaxed without any implications for our main results. Hsieh and Klenow (2009) allow for distortions in both output and labor. The labor distortion is isomorphic to firm-level differences in wages. The impact of this distortion on total factor productivity does not change the impact of distortions in the perceived cost of capital (see equation 16 on page 1411 in that paper).

by variation in the true financial cost of capital, as shown in (15). Distortions in the perceived cost of capital causes the TFPR to deviate from this rational benchmark and leads to misallocation that decreases total factor productivity, which we turn to now.

Let $\text{TFP}_s^{\tau=0}$ denote the total factor productivity of sector s absent any distortions to the cost of capital ($\tau_{si} = 0 \forall s, i$). Given (14) and (15) as well as the joint log-normality of r_{si} and A_{si}, we can write the sector-level TFP loss coming from mistakes in the perceived cost of capital as

$$\log\left(\text{TFP}_s\right) - \log\left(\text{TFP}_s^{\tau=0}\right) = -\frac{\sigma}{2} \underbrace{\text{var}\left(\log(1 + \tau_{si})\right)}_{\text{excess volatility}}. \tag{16}$$

Expression (16) allows us to quantify the TFP loss coming from excess volatility in the perceived cost of capital. It shows that the effect of mistakes on total factor productivity is pinned down by the cross-sectional variance of the log of the cost of capital distortions τ_{si}. This number is the excess volatility estimated in the previous section, except it is in logs.

5.2   Estimates of the TFP Loss due to Misallocation

We quantify the excess volatility term $\text{var}\left(\log(1 + \tau_{si})\right)$ using the estimates from Section 4:

$$\text{var}\left(\log(1 + \tau_{si})\right) = \text{var}\left(\log(r_{i,t}^{\text{perc.}})\right) \times \widehat{\gamma}^{\text{excess}}, \tag{17}$$

where $\widehat{\gamma}^{\text{excess}}$ is based on the estimates from Table 3.[7]

In addition to the excess volatility, we need to calibrate the elasticity of substitution between products in a sector, σ. Existing work puts this estimate between 3 and 10 (see Broda and Weinstein 2006, Hendel and Nevo 2006, and Hsieh and Klenow 2009). We use 5 in our baseline quantification.

We consider four estimates of TFP loss in Table 4. In the first estimation, we consider the excess volatility that comes from the implied cost of capital and includes both time series and cross-sectional variation (Table 4, Panel B, column 1). In this

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[7]The estimates in Table 3 come from regressions with untransformed outcome and regressor, whereas the model-based equation calls for log-log regressions. However, this difference is immaterial because the log-log regression gives almost identical estimates.

estimation, we find a TFP loss of 15.3% due to excess volatility in the perceived cost of capital. In the next estimation, we focus on excess volatility coming only from cross-sectional variation, which maps more clearly to the steady-state model. This gives a TFP loss of 13.7%, which is close to the first estimate because most of the excess volatility comes from cross-sectional variation (see Tables 2 and 3). In the next estimation we use the excess volatility estimated using realized returns (Panel A of Table 3), which gives similar results. Finally, lowering the elasticity of substitution between products in a sector, σ, to 3% decreases the estimate to around 10% (the impact of σ on the TFP loss can be inferred from 16). These results emphasize a new mechanism that contributes to the significant capital misallocation that has been found in the literature (David et al. 2016, Restuccia and Rogerson 2017, David and Venkateswaran 2019).

In the last rows of Table 4, we ask how the allocation of capital would change if firms were forced to all use the same cost of capital. Forcing all firms to use the same cost of capital would remove investment mistakes that come from their current mistakes, but it would also generate new mistakes from leaving true variation out from the perceived cost of capital. Given that the excess volatility is substantially larger than the true volatility, the cost of capital–and the allocation of capital–would be closer to correct. To illustrate this result, we calculate capital distortions arising from the current excess volatility and compares that to the capital distortions we would observe if we remove all variation in the perceived cost of capital. To calculate these distortions, we calculate the model implied firm-level capital choice from the observed perceived cost of capital and compare that to the capital choice the firm would make if they had used the true cost of capital. The total capital distortions is the firm-level average distortions (measured in absolute percent). To calculate to true cost of capital, we assume that firms' perceived cost of capital captures all true variation in the cost of capital plus excess volatility.

The first row shows that the observed level of excess volatility leads the average firm to distort its capital by 24.2%. If we instead force all firms to use the same cost of capital, the average capital distortion is less than half as large, at 10.9%. These results highlight how capital allocation would be closer to optimal if all firms used the same cost of capital in their investment decisions. While such a rule seems incompatible with the American economy, state-owned enterprises in China were subject to a uniform cost of capital until recently (He et al. 2022). While we have

focused on capital distortions in this counterfactual, it is also the case that forcing all firms to use the same cost of capital would also lead to an increase in TFP. This increase is, however, partly mechanical, as TFP in this model always increases when dispersion in the marginal products of capital decrease, irrespective of whether the dispersion is driven by mistakes or variation in the true cost of capital (see also David et al. (2022)).

5.3 Discussion: The Perceived Cost of Capital and Real Decisions

The model above assumes that the perceived cost of capital determines the allocation of capital. In the model, the perceived cost of capital equals the required return on new investments, with firms continuing to invest until the marginal return from investing equals this required return. Mistakes in the perceived cost of capital therefore directly impact firm investment and the allocation of capital.

In practice, firms' perceived cost of capital may have a more muted impact on investment. Firms do not always use the perceived cost of capital as required return on new investments (Jagannathan et al. 2016, Graham 2022). Rather, firms' required rates of return are distinct objects, often known as discount rates or hurdle rates. However, Gormsen and Huber (2023) shows that firms' perceived cost of capital influences firms' discount rates and that firms' discount rates ultimately influence investment. This relation is far below one-to-one in the short run, but, in the long run, the perceived cost of capital strongly affects discount rates.

The long-run impact of the perceived cost of capital on discount rates and capital allocation is also apparent when analyzing firms' return on invested capital (ROIC). Firms' ROIC measures the total income from all previous investments relative to the capital invested. If discount rates and investments are shaped by the perceived cost of capital in the long run, the average return on invested capital should be higher for firms with higher perceived cost of capital. We indeed find that firms with a 1 percentage point higher perceived cost of capital have a 0.5 percentage point higher ROIC.

The perceived cost of capital influences long-run ROIC and investment because it is highly persistent. To illustrate this persistence, we leverage the panel structure of our data. We regress a firm's current perceived cost of capital on its lagged perceived

cost of capital and estimate autoregressive coefficients:

$$r_{i,t}^{\text{perc.}} = \sum_{j=1}^{9} \varphi_j r_{i,t-j}^{\text{perc.}} + FE_j + e_{i,t},$$

where FE_j represent lag-specific fixed effects and $j = (1,..,9)$ captures lags. Figure 6 shows that the autoregressive coefficients fall from 0.9 to 0.6 in the first six years. From year six onward, the curve flattens and the autoregressive coefficients stabilize around 0.6. This finding highlights a high degree of persistence in the perceived cost of capital, consistent with the empirical relation between firms' return on invested capital and perceived cost of capital discussed above.

We conduct two robustness exercises that take into account that discount rates do not always equal the perceived cost of capital. In the first exercise, we follow the model by Fukui et al. (2024), which formalizes the evolution of discount rates in relation to the perceived cost of capital. In the model, firms are subject to a Calvo friction and can only adjust their discount rates at random intervals. This formulation is consistent with the empirical evidence on how firms set their discount rates relative to the perceived cost of capital. In the model, firms that can adjust their discount rates make an optimal choice taking as given that they will not be able to change the discount rate again until the Calvo friction randomly allows them to do so. The optimal discount rate $\delta_{i,t}^*$ is given by the recursive relation

$$\delta_{i,t}^* = \frac{1 + \bar{r}_i - \theta}{1 + \bar{r}_i} r_{i,t}^{\text{perc.}} + E_t[\delta_{i,t+1}^*], \tag{18}$$

where θ captures the probability that firms are not allowed to update their discount rates (the Calvo friction) and $\bar{r}_i$ is the long-run average perceived cost of capital of firm i. By using the estimated persistence in the perceived cost of capital from Figure 6 and the Calvo parameter calibrated in Fukui et al. (2024), we can calculate optimal discount rates following (18) and estimate the associated misallocation. This exercise results in an estimated TFP loss of 7%. The lower loss arises because the excess volatility in the perceived cost of capital is only partly incorporated into discount rates.

In the second robustness exercise, we interpret all deviations between discount rates and the perceived cost of capital as additional mistakes. The additional mistakes

exacerbate the loss arising from excess volatility in the perceived cost of capital and the estimated TFP loss increases to above 30% in our most conservative estimate. We refrain from labeling all differences between discount rates and the perceived cost of capital as mistakes, which means that the estimated 30% loss may be an overestimate. However, it is plausible that at least part of the difference between discount rates and the perceived cost of capital captures mistakes, in which case the TFP loss would indeed be even larger because discount rates and the perceived cost of capital differ. (See Gormsen and Huber 2023 for why discount rates that deviate from the perceived cost of capital may be optimal for firms.)

Discount rates are, as mentioned, generally higher than firms' perceived cost of capital (Graham 2022, Gormsen and Huber 2023). While this may, in principle, lead to additional misallocation of capital, it does not influence the estimates of misallocation in our model. We follow Hsieh and Klenow (2009) and assume a fixed capital supply, which means that level distortions do not influence estimates of misallocation (see equation 16).

Overall, the analysis of this section suggests that excess volatility in the perceived cost of capital leads to misallocation and an aggregate productivity loss. Differences in the perceived cost of capital across firms are highly persistent and ultimately affect firm investment (as evidenced by the long-run relation between the perceived cost of capital, discount rates, and the return to invested capital). Even when we allow for analyses where discount rates differ from the perceived cost of capital, we still find that excess volatility in the perceived cost of capital generates first-order productivity losses.

6   Production-Based Asset Pricing Meets the Perceived Cost of Capital

Our results challenge models in which rational expectations about the cost of capital are important. One example is production-based asset pricing. In this section, we argue that mistakes in firms' perceived cost of capital challenge this literature. We first discuss general challenges and we then reject the "Investment CAPM," a popular production-based asset pricing model.

6.1 Implications for Production-Based Asset Pricing

The starting point for most of production-based asset pricing is the idea that firms know the stochastic discount factor (SDF) and make decisions to maximize the value of the firm implied by the SDF. Firms' investment decisions are therefore going to represent optimal investment decisions given the prevailing SDF. From this starting point, production-based asset pricing attempts to learn the parameters of the SDF through firms' investment decisions and to explain cross-sectional variation in expected returns through the leans of optimal investment decisions by firms.

If firms know the SDF and use it to make investment decisions, as assumed in production-based asset pricing models, then firms should set their perceived cost of capital in line with the SDF. Specifically, firms' perceived cost of capital should be the best available estimate of expected returns on the firms' outstanding securities. The results presented so far show that that this is not the case.

Despite the large mistakes in the perceived cost of capital, there are certain aspects of expected returns that are properly incorporated into the perceived cost of capital. The analysis in Section 3 suggests that time variation in expected returns and certain cross-sectional risk factors are properly incorporated. These findings raise the possibility that production-based asset pricing models revolving around these dimension may work well.

To explore the scope of production-based asset pricing models, we expand the analysis of the stylized risk factors in Section 3.2 to a comprehensive analysis of all the risk factors studied in asset pricing. We estimate risk premia implied by the perceived cost of capital–which we refer to as perceived risk premia–for each of the 153 risk factors in the dataset of Jensen et al. (2023). We use a multifactor model that controls for the market and leverage, as explained in Section Appendix D.2. We compare these risk premia to the "true" long-run risk premia associated with the different factors, as estimated by Cho and Polk (2024).

Figure 7 illustrates the relation the between the perceived and the true risk premia. Jensen et al. (2023) group the 153 factors into seven main groups. For each group, we project the perceived factor premia onto the true premia. The figure reports the associated slope coefficients along with R^2 values for all groups except momentum.[8]

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[8]We exclude the momentum factors as these are transient factors that should not explain the cost of capital under the standard view. We indeed find slope coefficients close to zero, although standard errors are very large.

The figure reveals a strong relation between perceived and true factor premia for the category called "Traditional risk factors and liquidity." This group includes risk factors based on volatility and skewness of stock returns as well as measures of liquidity. It also includes the size factor.[9] The slope coefficient and R^2 are both close to 1, suggesting a strong relation between perceived and true factor premia within this category. In unreported results, we find that the intercept is close to zero for this group, which suggests that the perceived premia are correct on average (given the slope is almost 1). The strong relation between perceived and true factor premia within this category is consistent with the results on the stylized drivers in Section 3.2.

For most other categories, however, we observe a weak relation between true and perceived factor premia. The slopes coefficients are close to zero. This finding suggests a limited relation between true and perceived factor premia within a category, but it does not rule out that the risk premia on average are correct within a category. For the value factors, for instance, the average perceived factor premium is positive, as is the case for the true premia, but the slope is low because the ranking of the perceived value premia is largely orthogonal to the ranking of the true value premia. For investment factors, the average factor premium has the wrong sign, and for the remaining groups the average factor premium is close to zero (see Appendix D.2).

6.2   Testing the Investment CAPM

We illustrate the challenges for production-based asset pricing through a test of the Investment CAPM (Hou et al. 2015). This model is used to account for cross-sectional variation in expected stock returns through the lens of rational behavior of firms, and it is sometimes branded as a rational explanation of asset pricing anomalies (see discussion in Nagel 2019). The model relies on specific assumptions about how firms' perceived cost of capital varies with expected stock returns. We test and reject these assumptions.

In the model, firm investment depends on the cost of capital and thereby expected stock returns. The model argues that expected returns, profitability, and investment are all directly related. If a firm is highly profitable but invests sparingly, it must be because the firm has a high cost of capital (i.e., high expected stock return). Hou

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[9] Jensen et al. (2023) refers to the group as "trading frictions," but we refer to it as traditional risk given the inclusion of standard risk measures such as volatility, skewness, and size.

et al. (2015) formalize this logic in a simple one-period investment model where firms optimally choose investment based on expected stock returns and expected profits. Adjustment costs are quadratic in investment rates and capital depreciates fully over one period. In this setting, the optimal investment rate for a fully equity-financed firm is

$$1 + \frac{I_t}{K_t} = \frac{E_t[X_{t+1}]}{E_t[r_{t+1}]} \times \frac{1}{a}, \tag{19}$$

where I_t is investment at time t, K_t is capital at time t, $E_t[r_{t+1}]$ is the expected stock return for the firm at time t for the period between t and $t+1$, $E_t[X_{t+1}]$ is the expected profit at time t for the period between t and $t+1$, and a is a parameter governing adjustment costs. The equation suggests that firms with greater investment have lower expected stock returns, controlling for the profitability of the firm.

Following this argument, Hou et al. (2015) construct investment and profit factors and estimate that firms with high investment indeed have low expected stock returns (keeping profitability fixed). The authors, through the lens of the model, argue that this empirical finding must be driven by the fact that firms with high investment rates perceive that they have a low cost of capital and adjust their investment accordingly.

Our new data allow us to directly test whether firms with high investment rates indeed perceive their cost of capital to be lower. We find the opposite: firms with high investment rates do not have lower perceived cost of capital. If anything, the relation points toward a positive cross-sectional relation between investment rates and the perceived cost of capital. This finding challenges the basic idea behind the Investment CAPM's interpretation of the data.

Our tests of the Investment CAPM are reported in Table 5. In the first three columns, we replicate the empirical findings of the investment CAPM literature by regressing future realized stock returns on the ex ante investment characteristic of the firm. Following Hou et al. (2015) and Fama and French (2015), we consider asset expansion over the prior year as the investment characteristic (i.e., Investment$_t$ = Assets$_t$ − Assets$_{t-1}$). We measure the investment characteristic in cross-sectional percentiles of the population of firms in the country at a given date (ranging from 0 to 1). In the first three columns, we consider all firms in the CRSP/Compustat sample and all quarters between January 2002 and December 2022. We find similar results to Hou et al. (2015). The relation between future stock returns and the

31

investment characteristic is strong, negative, and significant in column 1. It becomes even stronger when we condition on bins for deciles of firm profitability in column 2. Further controlling for market beta and size does not change the coefficient much in column 3.

In columns 4 to 6, we confirm that the same results also hold in the subsample of firm-quarter observations where we observe the perceived cost of capital. The slope coefficients are similar to the full sample regressions, suggesting that our sample of firms is similar to the population along this dimension (see also Section 2.3).

In columns 7 to 9, we use the perceived cost of capital as left-hand side variable instead of realized future stock returns. The slope coefficients are now of the opposite, positive sign: the greater firm investment, the greater the perceived cost of capital. The effect is significant once we condition on profitability, as prescribed by the Investment CAPM. These results reject the fundamental idea behind the Investment CAPM. Firms with high investment (for a given level of profitability) do not have a low perceived cost of capital. The low future realized returns on high investment firms therefore cannot be interpreted as the outcome of an optimal capital budgeting decision where firms with low expected returns use a low cost of capital.

We visualize the rejection of the Investment CAPM in Figure 8 using two binscatters. The left-hand panel shows a negative relation between future realized stock returns and the ex ante investment rate (controlling for country, date, and profitability). The right-hand panel shows a positive relation between the ex ante perceived cost of capital and the ex ante investment rate (using the same controls). The opposite slopes are inconsistent with the Investment CAPM.

It may be surprising that high investment is not associated with a low perceived cost of capital. However, the reason is that firms with high asset expansion also perceive very good investment opportunities, which drives them to invest more despite the high cost of capital. Once we properly account for investment opportunities, the perceived cost of capital and discount rates indeed predict investment with the correct sign (see discussion in Appendix E and in Gormsen and Huber 2023). However, the Investment CAPM argues that there is no need to control for investment opportunities because the high investment rates of firms with high asset expansion are driven by the perceived cost of capital. It is this crucial assumption for the model that our analysis rejects.

7   Conclusion

A bedrock assumption of standard investment models is that firms perfectly know their cost of capital and invest accordingly. We indeed find that firms' perceived cost of capital follows standard theory along a few dimensions. For instance, the average perceived cost of capital fluctuates correctly over time with interest rates and risk premia. Similarly, firms incorporate traditional cross-sectional drivers of expected returns in their perceived cost of capital.

However, 80% of variation in the perceived cost of capital represents mistakes, in the sense that it is not justified by variation in risk premia and interest rates. These mistakes occur because firms fail to properly incorporate true variation from risk factors and because firms add idiosyncrasies orthogonal to their true factor exposure. The mistakes are large enough to lead to substantial misallocation of capital. In our baseline estimates, the mistakes decrease aggregate TFP by around 10%. Capital would, in fact, be closer to optimal if all firms were forced to use the same cost of capital, as used to be the case for state-owned enterprises in China (He et al. 2022).

One of the main lessons taught in business school is that firms should account for risk in their investment decisions and that they should do so by using an appropriate cost of capital (Welch 2011). Our results suggest that most firms fail to implement this lesson properly. Absent better guidance on how to determine the cost of capital, the current business school curriculum may be counterproductive relative to a benchmark where firms ignore cross-sectional variation in risk and all use the same cost of capital. Our results underscore the relevance of further research into how firms can robustly estimate their cost of capital and make investment decisions in the presence of misspecifications in the cost of capital (Hansen and Sargent 2001, Hommel et al. 2023).

The results challenge the assumption that firms rationally know their cost of capital. A prominent literature that relies on this assumption to study asset prices and firm investment is production-based asset pricing. We formally show that the data on the perceived cost of capital is inconsistent with the "Investment CAPM," a prominent production-based model. However, more generally, the assumption plays a key role in much of modern macro-finance. Future work may find it helpful to account for the large differences between firms' perceived cost of capital and their true cost of capital. To this end, we share predicted data on firms' perceived cost of capital and discount rates online under costofcapital.org.

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36

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Table 1
Summary Statistics

This table reports summary statistics at the level of firm-quarter observations. The perceived cost of capital, the perceived cost of debt, and the discount rate are observed in the conference call data. The remaining variables are from the factor zoo data and reported in "percentile ranks," relative to the universe of firms in Compustat in the same year and country of listing. Mean values of variables in percentile rank around 50 imply that firms in the sample are close to the mean in the country-year peer group. We report statistics for the factor zoo for all firms where we observe the perceived cost of capital, the county-level earnings yield, and the long-term government interest rate (as required for Table 2). Observations include the years between 2002 to 2022.

	N	mean	p5	p95
Perceived cost of capital	3,139	8.67	5.30	13.0
Perceived cost of debt	5,165	4.66	1.70	8.90
Perceived cost of equity	485	10.3	5.00	15.0
Discount rate	3,286	15.4	8.00	25.0
Market beta (percentile rank)	2,134	52.4	10.0	92.8
Investment rate (percentile rank)	2,229	51.1	15.5	89.3
Book-to-market ratio (percentile rank)	2,191	47.7	8.86	87.7
Leverage (percentile rank)	2,230	61.2	25.0	93.8
Profits / assets (percentile rank)	2,102	49.8	13.6	86.9
Market size (percentile rank)	2,233	84.8	55.0	99.5

Table 2
Time Variation in the Perceived Cost of Capital

This table reports results of regressions of firm-level perceived cost of capital on the contemporaneous earnings yield, plus expected inflation, of the stock market in the country of the firm as well as the long-term interest rates in the country. Firms are denoted by i and k denotes the country of residence of firm i. The sample includes 2002 to 2022. Standard errors are clustered by firm. Statistical significance is denoted by *** p<0.01, ** p<0.05, * p<0.1.

	(1)	(2)	(3)
	Perceived Cost of Capital$_{i,t}$		
Sample:	U.S. only		Global
Earnings yield + exp. inf$_{k,t}$	0.52***	0.59***	0.51***
	(0.12)	(0.22)	(0.12)
Long-term interest rate$_{k,t}$	0.28***	0.32***	0.25***
	(0.077)	(0.065)	(0.041)
Observations	1,543	1,543	2,625
R-squared	0.051	0.84	0.89
FE	None	Firm	Firm
R^2	0.051	0.89	0.89
Within R^2	0.051	0.16	0.15

Table 3
Excess Volatility in the Perceived Cost of Capital

This table estimates the part of the variation in the perceived cost of capital that represents excess volatility. The excess volatility is estimated as the slope coefficient in a regression of the difference between the perceived cost of capital and the true cost of capital onto the perceived cost of capital. In Panel A, we proxy for the true cost of capital using future realized 5-year returns, as explained in Section 4.3. In Panel B, proxy for the true cost of capital using the implied cost of capital, as explained in Section 4.4. Standard errors in Panel A are double clustered at the firm and year level and standard errors in Panel B are double clustered at the industry and year level. The sample is 2002-2022.

	Panel A: Error based on realized returns$_{i,t \to t+5\text{years}}$					
Perceived CoC$_{i,t}$	0.73***	0.89***	0.96***	0.68***	0.83***	0.85***
	(0.23)	(0.23)	(0.23)	(0.23)	(0.22)	(0.22)
Controls:						
Beta/size/value				X	X	X
FE	None	Country	Country/Year	None	Country	Country/Year
P(slope = 1)	0.25	0.62	0.84	0.16	0.43	0.51
Observations	1,449	1,449	1,449	1,326	1,326	1,326
R-squared	0.003	0.029	0.136	0.016	0.034	0.147

	Panel B: Error based on implied cost of capital$_{i,t}$					
	OLS			2SLS		
Perceived CoC$_{i,t}$	0.83***	0.85***	0.91***	0.53***	0.47***	0.61***
	(0.052)	(0.047)	(0.043)	(0.11)	(0.13)	(0.14)
Instrument				Predicted perceived cost of capital$_{i,t}$		
FE	None	Country	Country/Year	None	Country	Country/Year
P(slope = 1)	0.00	0.00	0.06	0.00	0.00	0.01
Observations	2,105	2,105	2,105	1,557	1,557	1,557
R-squared	0.325	0.355	0.394	0.319	0.285	0.343

Table 4
Misallocation from Excess Volatility in the Perceived Cost of Capital

This table reports the TFP loss arising from the excess volatility in the perceived cost of capital, according to the model in Section 5.1. The TFP loss is quantified using equation (16). The estimates are calculated based on an elasticity of substitution of products, σ, equal to 5, unless specified otherwise. The table shows results for 3 different estimates of the amount of excess volatility in the perceived cost of capital. Row 1 and 4 uses overall excess volatility, as estimated using the ICC in Table 3. Row 2 calculates the excess volatility coming from within country-year variation in the perceived cost of capital, as estimated using the ICC in Table 3. Row 3 uses overall excess volatility, as estimated using realized returns in Table 3. The bottom two rows estimates the average firm-level capital distortions under two different scenarios. The distortions are the capital stock implied by the perceived cost of capital relative to the optimal capital stock implied by the true cost of capital. The first of the two rows shows the distortions for the observed perceived cost of capital and the second of the two rows shows the distortions that would arise under a counterfactual where all firms had the same perceived cost of capital (keeping the true cost of capital unchanged).

	Percentage change in TFP
Estimates of total misallocation	
All excess volatility	-15.3%
(excess volatility implied by column 1, Panel B, Table 3)	
Excess cross-sectional volatility	-13.7%
(excess volatility implied by column 3, Panel B, Table 3)	
Excess volatility implied by realized returns	-13.5%
(excess volatility implied by column 1, Panel A, Table 3)	
Low elasticity of substitution ($\sigma = 3$)	-9.8%
(excess volatility implied by column 1, Panel B, Table 3)	
Capital distortions	
Average capital distortions from observed $r^{\text{perc.}}$	24.2%
Average capital distortion if $r^{\text{perc.}} = \text{constant}$	10.9%

Table 5
Testing the Investment CAPM

This table reports results of panel regressions of firm-level measures of returns on firm-level characteristics used by the "Investment CAPM". In column (1) to (3), we regress future 3-year realized stock returns on the given firms' ex ante investment characteristic, along with controls. In column (4) to (6), we run the same regression for subset of firm/quarters where we also observe firms' perceived cost of capital. In column (7) to (9), we run the same regressions but instead using perceived cost of capital as the dependent variable. All regression include country and date fixed effects. We control for three different ex ante firm-level characteristics, namely beta, size, and return on equity (profitability). We assign firm-level characteristics to 1 of 10 bins and control for inclusion in these bins using fixed effects. The investment characteristic is growth in total assets over the previous year and it is measured in cross-sectional percentiles ranging from 0 to 1. The sample includes 2002 to 2022.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	All firm/quarters			Firm/quarters with observed perceived cost of capital					
	Realized stock returns			Realized stock returns			Perceived cost of capital		
Asset expansion	-1.43**	-6.58***	-4.61***	-3.01	-4.60*	-4.40*	0.40	0.57**	0.63***
(investment)	(0.61)	(1.35)	(1.19)	(2.28)	(2.45)	(2.20)	(0.24)	(0.25)	(0.23)
Controls:									
Profits bins		X	X		X	X		X	X
Beta bins			X			X			X
Size bins			X			X			X
Observations	739,481	723,243	722,926	1,352	1,334	1,334	2,000	1,960	1,960
R-squared	0.118	0.158	0.183	0.215	0.230	0.264	0.187	0.217	0.345
Cluster	Country/date	Country/date	Country/date	Country/date	Country/date	Country/date	Firm/date	Firm/date	Firm/date

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Figure 1
The Time Series of the Perceived Cost of Capital

This figure shows average perceived cost of debt and capital for firms in the US, along with measures of the financial cost of capital. In the left-hand figure, we plot the average cost of capital along with the earnings yield for the U.S. stock market (the inverse of the CAPE ratio) + expected long-run inflation from the Michigan survey. On the right-hand figure, we plot the average cost of debt along with the long-term yield on treasuries.
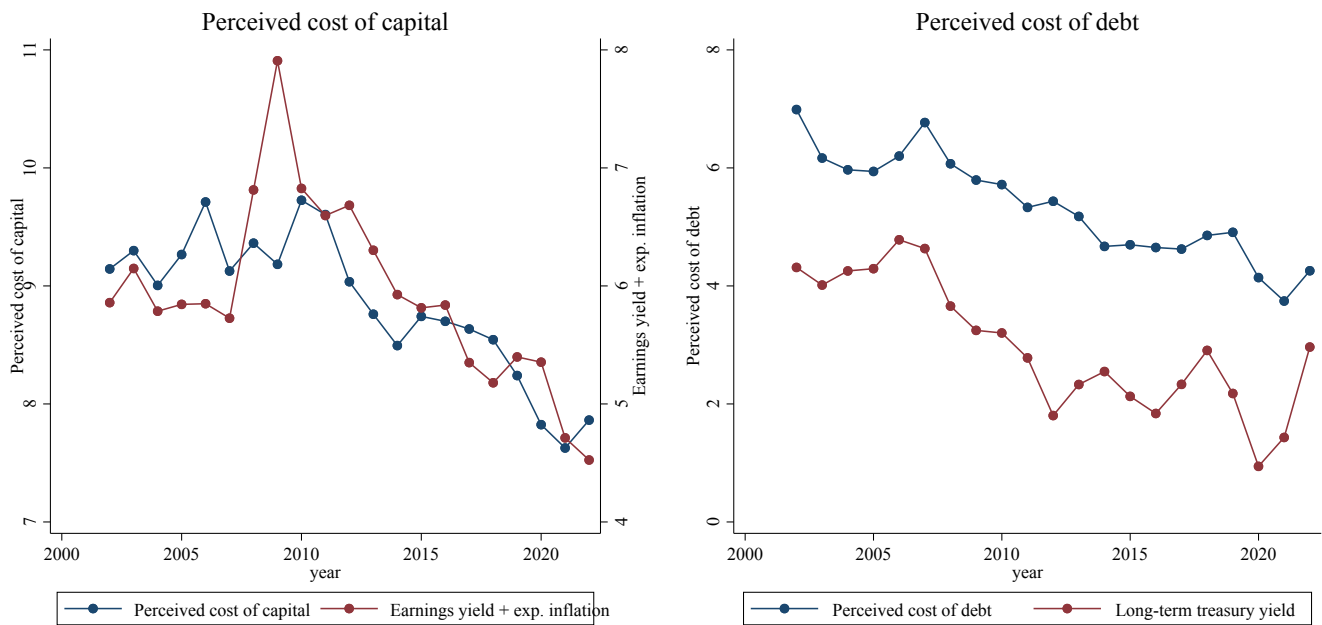
Figure 2
The Cross-Section of the Perceived Cost of Capital

This figure shows the perceived of capital for firms sorted into bins based on firm-level characteristics. The 4 characteristics are leverage, market beta, size, and value. Leverage, beta, and, book-to-market are measured in cross-sectional percentiles of the population of firms in a country on a given date. For size, we assign all firms to one of 5 size categories based on categorization from Jensen et al. (2023). The three other characteristics are sorted into equal-sized groups. The sample includes 2002 to 2022.
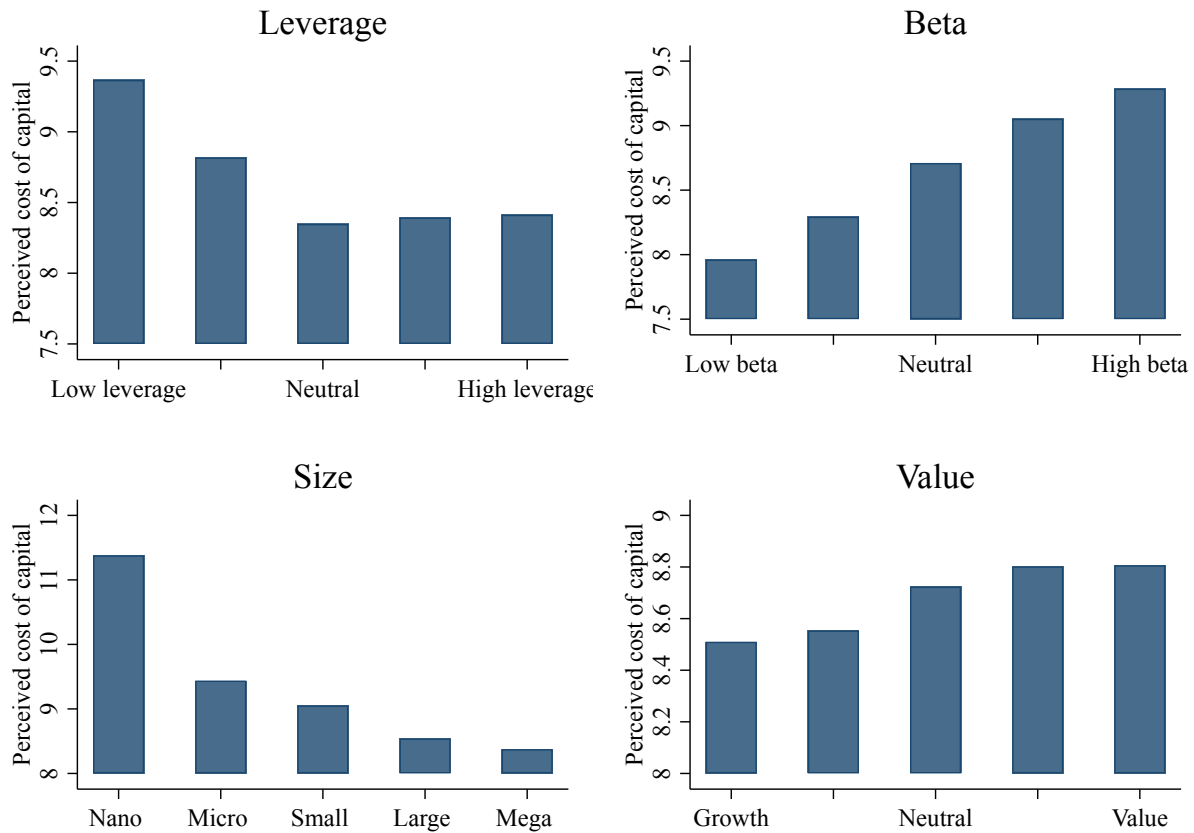
Figure 3
A Parsimonious Model of the Perceived Cost of Capital

This figure shows slope coefficients of the predicted values of firms' perceived cost of capital onto the variables selected by the Lasso procedure. The dependent variable in the Lasso regression is firms' perceived cost of capital in a given quarter. The set of possible explanatory variables includes the firms exposure to the 153 risk factors in Jensen et al. (2023)–which risk exposure is measured by firm characteristics–as well as a dummy for the region (U.S. versus European firm). The firm-level characteristics are measured in cross-sectional percentiles of the universe of firms in a given country at the give time. The variable ranges from 0 (lowest) to 1 (highest) and the left-hand side is measured in percentage points, so a loading of 1 means that the perceived cost of capital is predicted to be 1 percentage points higher for firms with the highest characteristics relative to firms with the lowest. The data is fitted based on firms in Europe and US between 2002 and 2021.
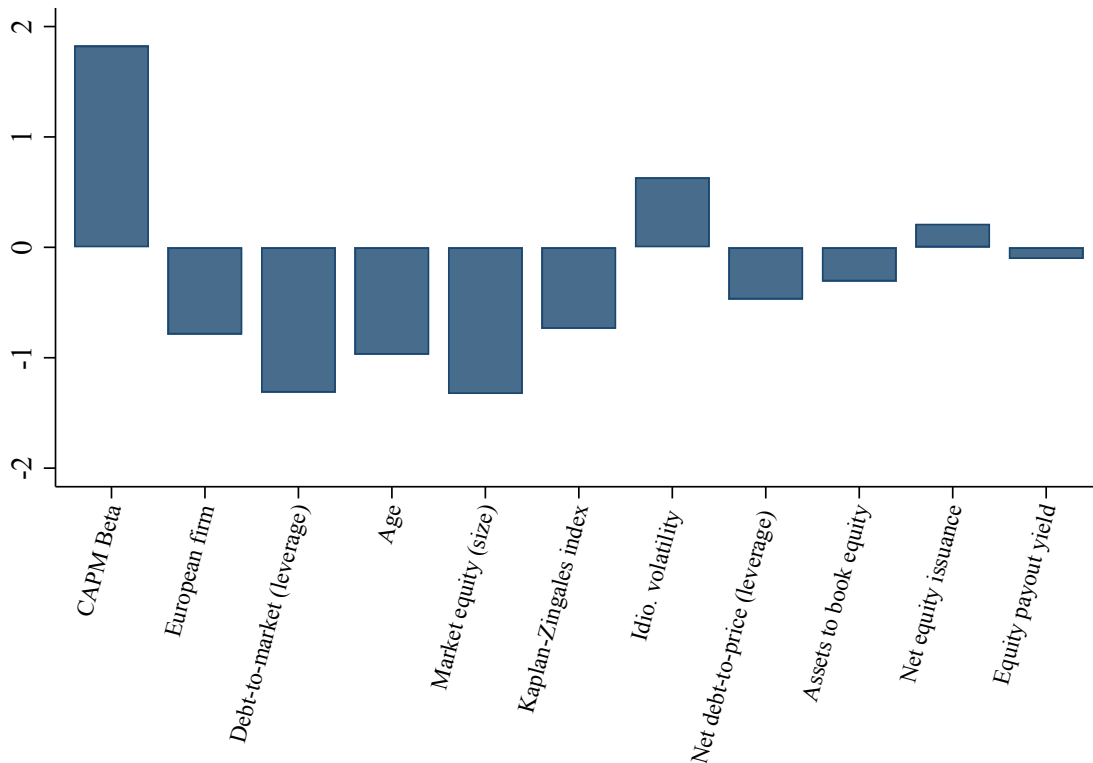
Figure 4
Histograms for the Perceived Cost of Capital and Equity

This figure shows histograms for the perceived cost of capital and the perceived cost of equity for the firms in the sample.
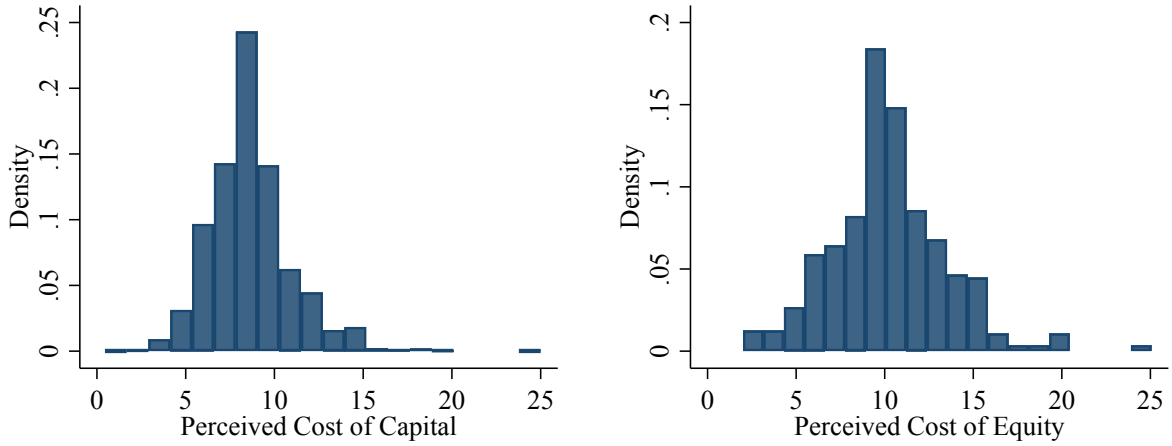
Figure 5
Excess Volatility in the Perceived Cost of Capital, Equity, and Debt

This figure shows the fraction of the overall variance of the perceived cost of capital, equity, and debt that constitute excess volatility. The excess volatility is estimated as the slope coefficient in a regression of the error in the perceived cost of capital, equity, and debt onto the variable in question (see equation 8). The error in the perceived cost of capital is estimated using the implied cost of capital method, as in Table 3 Panel B. The error in the perceived cost of equity is calculated relative to the implied cost of equity. The error in the perceived cost of debt is calculated relative to the same measure of true cost of debt as the one used for the cost of capital.
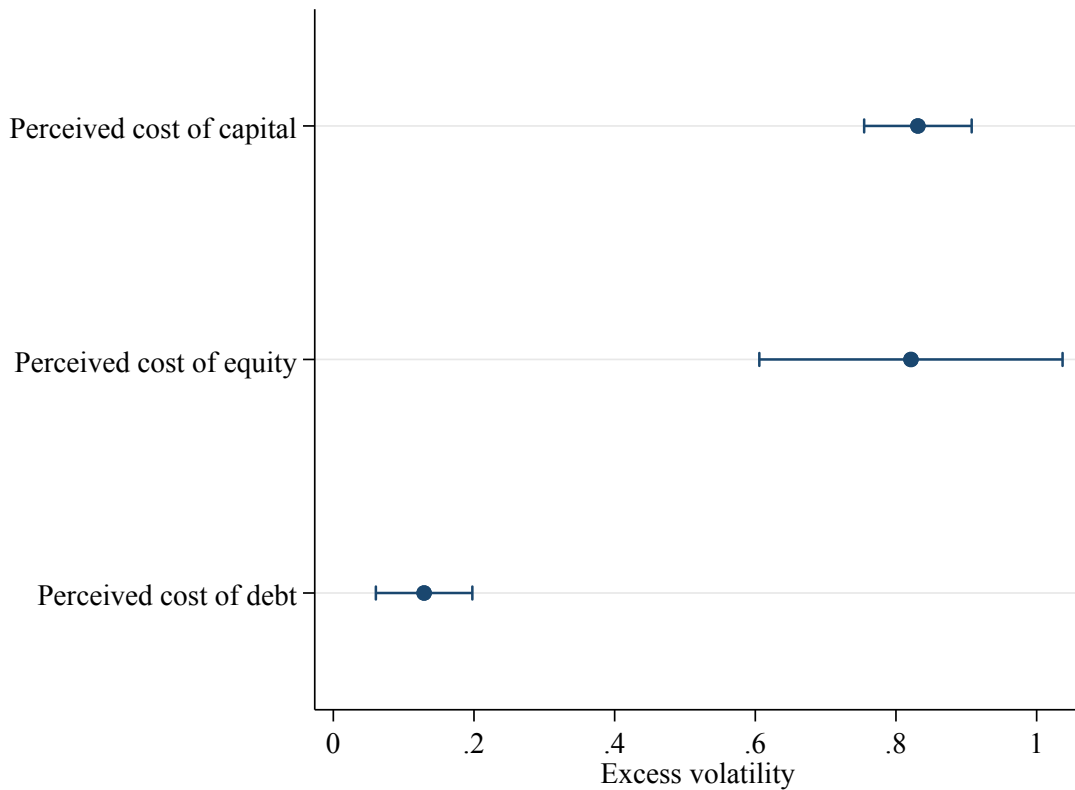
Figure 6
Persistence in the Perceived Cost of Capital

This figure shows slope coefficients φ_j from the following regression of the perceived cost of capital onto lags of the perceived cost of capital of the same firms:

$$r_{i,t}^{\text{perc.}} = \sum_{j=1}^{9} \varphi_j r_{i,t-j}^{\text{perc.}} + FE_j + e_{i,t},$$

where FE_j represent lag-specific fixed effects and $j = (1,..,9)$ the difference in years between the left- and righ-hand side observation of the perceived cost of capital. The group $j = 9$ includes all observations with differences above 9 years. We smooth estimates for $j \neq 1$ and 9 by averaging φ_j across the two nearest $j's$.
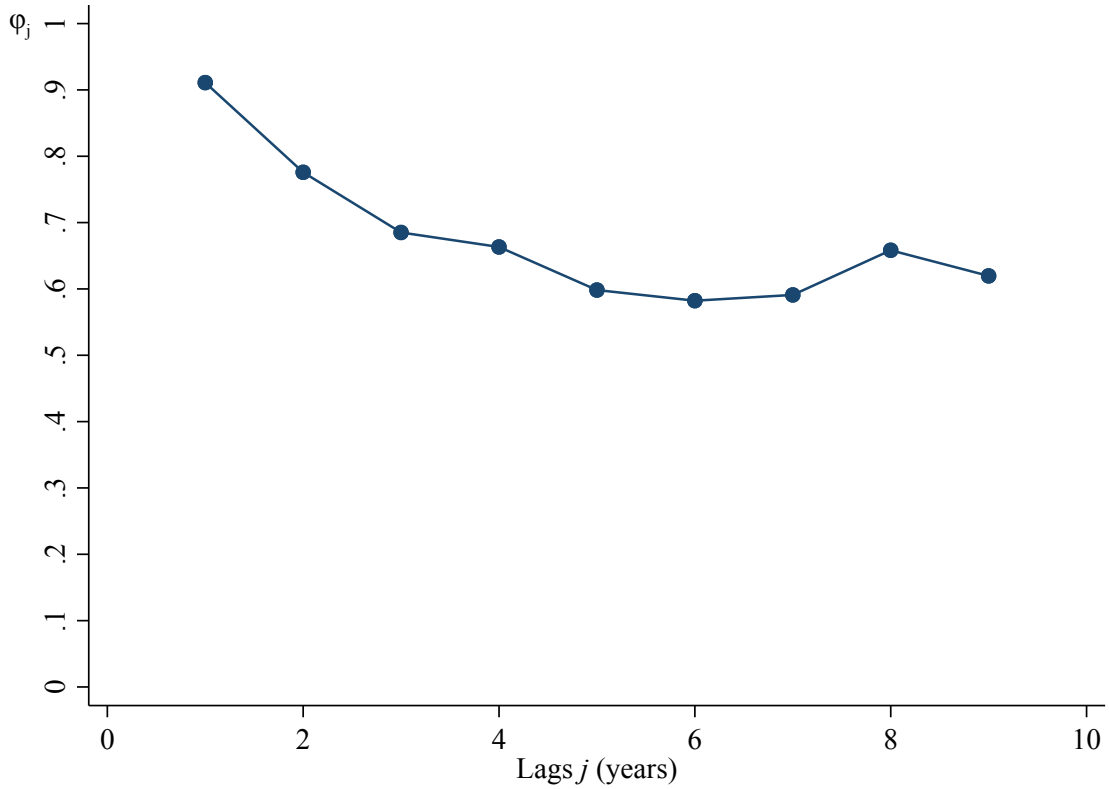
Figure 7
Perceived versus True Premia for Risk Factors

This figure shows slope coefficients from regressions of of risk premia reflected in the perceived cost of capital and the "true" risk premia estimated financial markets. For each group of risk factors M, we run the regressions

$$\lambda_k^{\text{perc.}} = a_M + \beta_M \lambda_k^{\text{true}} + e_{i,t},$$

where $\lambda_k^{\text{perc.}}$ and λ^{true} are the risk premium for the k'th risk factor in M. For each factor k, the associated risk premium is estimated in a model that control for one other risk factor, namely the market risk. The true risk premia are from Cho and Polk (2024) and the perceived risk premia are estimated as explained in the text. We observe in total 153 risk factors that are grouped into six different groups following Jensen et al. (2023).
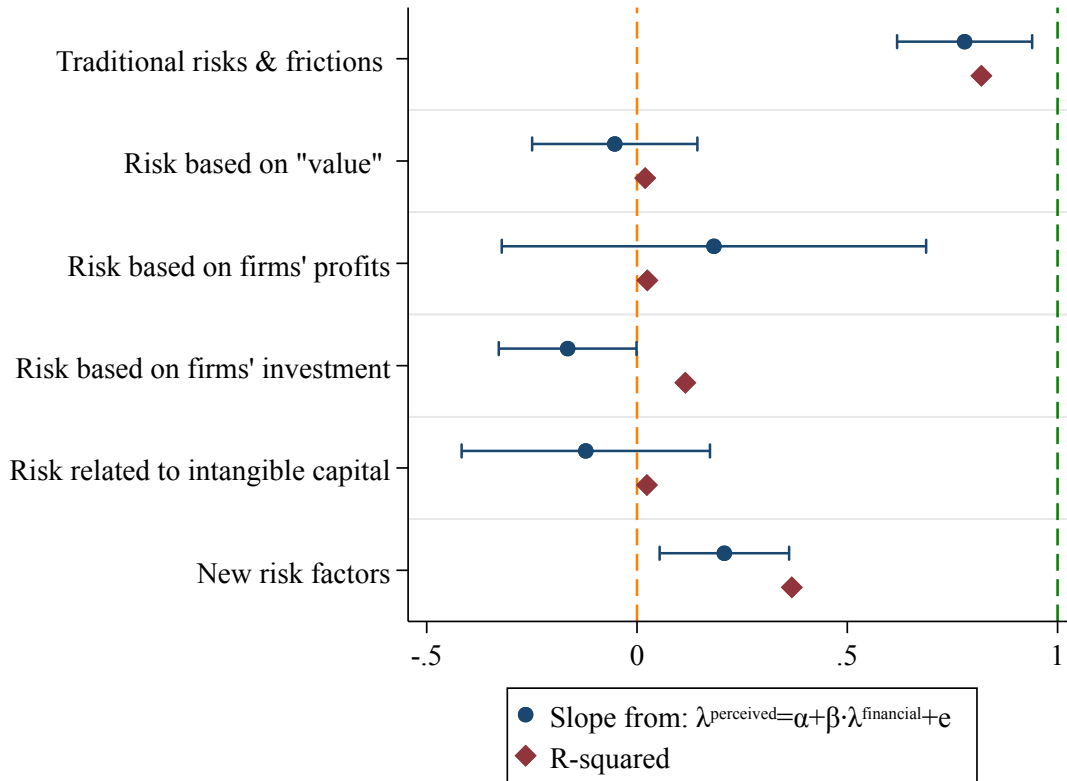

49

Figure 8
Testing the Investment CAPM

This figure shows binscatters for plots of future realized stock returns and perceived cost of capital against the firm-level investment rate. The left-hand figure plots the realized future 3-year return against the ex ante investment of the firm. Investment is measured as asset expansion and it is measured in cross-sectional percentiles of the full population of firms in the country at a given date. The right-hand figure plots the perceived cost of capital against firm-level investment. Both plots includes controls for country-date fixed effects as well as profit bins of the given firms. Profit bins are based on the return on equity, which is measured in cross-sectional percentiles of the full population of firms in the country at a given date. The sample includes 2002 to 2022.
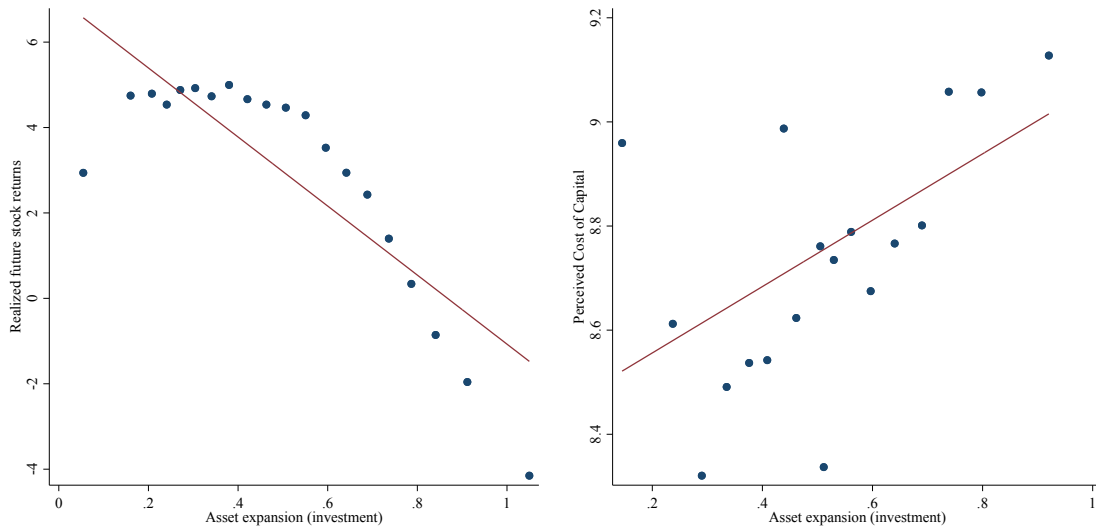
Online Appendix

Appendix A   Figures and Tables

Figure A1
A Parsimonious Model of Firm Discount Rates

This figure shows slope coefficients of the predicted values of firms' discount rates onto the variables selected by the Lasso procedure. The dependent variable in the Lasso regression is firms' discount rates in a given quarter. The set of possible explanatory variables includes the firms exposure to the 153 risk factors in Jensen et al. (2023)–which risk exposure is measured by firm characteristics–as well as a dummy for the region (U.S. versus European firm). The firm-level characteristics are measured in cross-sectional percentiles of the universe of firms in a given country at the give time. The variable ranges from 0 (lowest) to 1 (highest) and the left-hand side is measured in percentage points, so a loading of 1 means that the perceived cost of capital is predicted to be 1 percentage points higher for firms with the highest characteristics relative to firms with the lowest. The data is fitted based on firms in Europe and US between 2002 and 2021.
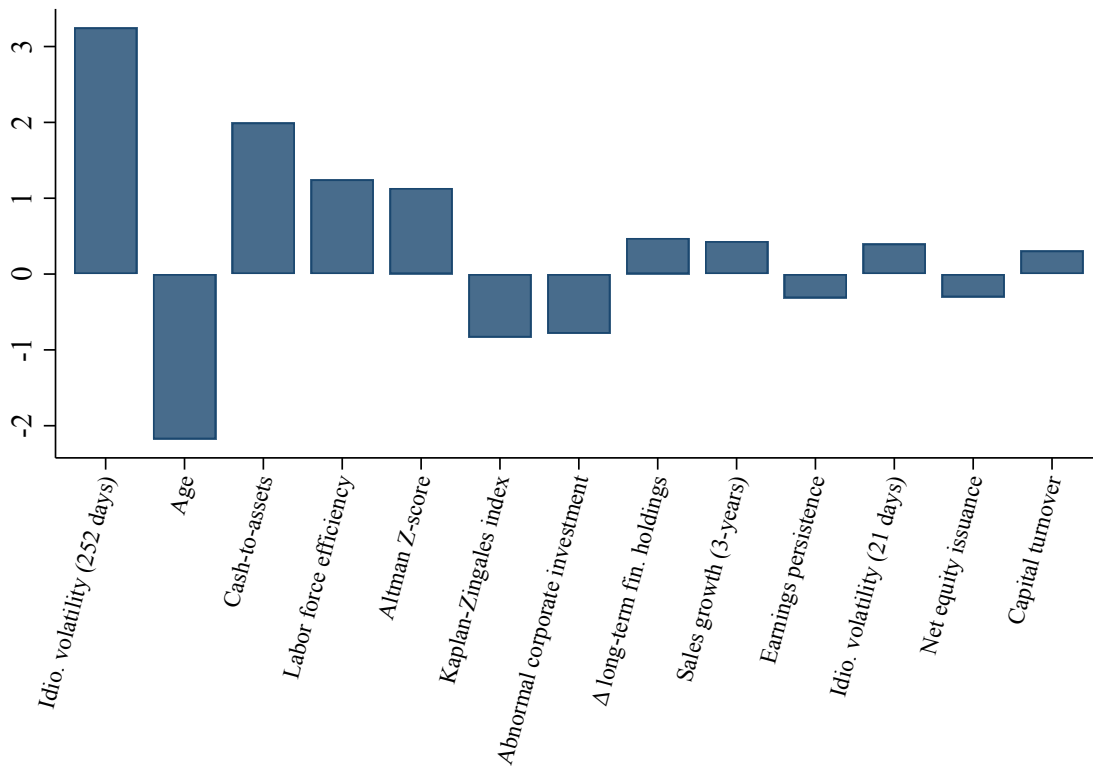
Table A1
The Perceived Cost of Capital and the Fama-French Model

This table reports results of regressions of firm-level perceived cost of equity on measures of firm-level exposure to the Fama and French (1993) factors. Exposure to equity factors is measured by the characteristic of the underlying factor, such as size and book-to-market. Perceived cost of capital is in percent and characteristics are in cross-sectional percentiles ranging from 0 to 1. The sample is 2002 to 2022. Standard errors are clustered by firm.

	(1)	(2)	(3)
		Perceived cost of capital$_t$	
Market Beta$_t$		2.91***	2.81***
		(0.29)	(0.27)
Market size$_t$			-1.49**
			(0.63)
Book-to-market$_t$			0.11
			(0.34)
Leverage ratio$_t$	-7.02***	-5.53***	-4.85***
	(1.85)	(1.57)	(1.54)
Leverage ratio$_t^{\text{squared}}$	4.26***	2.76**	2.10
	(1.59)	(1.37)	(1.37)
Observations	2,099	2,099	2,099
R-squared	0.231	0.335	0.343
FE	Ex/Year	Ex/Year	Ex/Year
Cluster	Firm/year	Firm/year	Firm/year
Within R^2	0.050	0.18	0.19

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A2
Summary of Factor Regressions

This table reports average results for factor regressions across different groups of risk factors. For each factor in our sample, we project the perceived cost of capital onto the given firm's market beta, leverage, leverage squared, and the firm's characteristic for the factor in question. All firm characteristics are measures in cross-sectional percentiles ranging from 0 to 1 and the cost of capital is measured in percentage points. All factors are signed such that higher exposure is associated with higher CAPM alpha in financial markets. The factors are grouped into categories as in Jensen et al. (2023). For each group of factors, we report the average factor premium (λ^i), the number of factors belonging to the category, the percent of factors for which λ^i has the same sign as that observed in financial markets, and the percent of factors that are significant against the one-sided alternative of having a different sign than the one observed in financial markets. A factor is significant if it has a p−value above 5% after doing a Benjamini and Hochberg (1995)-correction for number of factors tested in the given category. The sample is 2002 to 2021.

Factor category	Average λ^i	# of factors	% Correct sign	% Significant
Value	0.25	16	0.65	0.12
Trading frictions	0.22	24	0.66	0.16
Intangibles	0.15	29	0.53	0.20
Profitability	0.04	22	0.36	0.22
New	-0.09	14	0.33	0.00
Investment	-0.19	32	0.18	0.00
Momentum	-0.23	9	0.22	0.00
All	0.04	146	0.43	0.12

Table A3
The Cost of Capital Factor

This presents results of time series regressions of the return to the cost of capital factor on the Fama and French (1993) factors. We construct the cost of capital factor as follows. Each month, rank all firms based on the most recent estimate of their cost of capital (going no more than 10 years back). We then split firms based on the median market size of the firms in our sample and for each size group sort firms into three value-weighted portfolios based on the 30th and 70th percentile of cost of capital. Each month, the cost of capital factor goes long fifty cent in each of the two portfolios with high cost of capital and short fifty cent in each of the two portfolios with low cost of capital. Portfolios weights are refreshed and balanced every month. The sample starts in January 2005, to ensure at least three years of data on cost of capital, and ends in December 2022. The first column shows the weighted-average perceived cost of capital for the factor (the perceived cost of capital of the firms in the long leg minus the firms in the short leg). The next three columns show the realized returns on the factor. All returns are in monthly percent. The sample is U.S.only.

	(1) Perceived. CoC_t	(2)	(3) Realized return$_{t,t+1}$	(4)
Constant	0.41***	0.0067	-0.17	-0.11
	(0.0026)	(0.18)	(0.17)	(0.15)
$\text{MKT}_{t,t+1}$			0.25***	0.16***
			(0.037)	(0.036)
$\text{SMB}_{t,t+1}$				0.27***
				(0.066)
$\text{HML}_{t,t+1}$				0.26***
				(0.049)
Observations	216	216	216	216
P(intercept = 0.41)		0.026		
R-squared	0.000	0.000	0.173	0.355

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A4
Testing the Investment CAPM Using Discount Rates

This table reports results of panel regressions of firm-level discount rate on firm-level characteristics used by the "Investment CAPM". All regressions include country and date fixed effects. We also control for three different ex ante firm-level characteristics, namely beta, size, and return on equity (profitability). We assign firm-level characteristics to 1 of 10 bins and control for inclusion in these bins using fixed effects. The investment characteristic is growth in total assets over the previous year and it is measured in cross-sectional percentiles ranging from 0 to 1. The sample includes 2002 to 2022.

	(1)	(2)	(3)
		Discount rates	
Asset expansion (investment)	0.012	0.029***	0.012
	(0.010)	(0.011)	(0.0089)
Controls:			
Profits bins		X	X
Beta bins			X
Size bins			X
Observations	1,896	1,816	1,816
R-squared	0.130	0.198	0.286
FE	Country/date	Country/date	Country/date
Cluster	Firm/date	Firm/date	Firm/date

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A5
Predicting Perceived Cost of Capital and Discount Rates from the Duke-CFO Data

This table reports results of regressions where we use the predicted value of firms' perceived cost of capital and discount rates to predict the equivalent objects in the Duke-CFO data. The data in this regression are US only.

	(1) DukeCoC	(2) DukeCoC	(3) DukeHurdle	(4) DukeHurdle
predicted_costcap	0.74***	0.90***		
	(0.17)	(0.21)		
predicted_hurdle			1.02***	0.98**
			(0.38)	(0.38)
Constant	0.034**	0.021	0.027	0.031
	(0.014)	(0.018)	(0.036)	(0.037)
Observations	319	319	92	92
R-squared	0.057	0.067	0.118	0.136
FE	None	Year	None	None
Within R^2	0.057	0.057	0.12	0.11

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix B   Maximizing Stock Prices Based on the Stochastic Discount Factor

A firm faced with a new investment opportunity should discount each cash flow produced by the project separately using the stochastic discount factor and invest in the project if the total present value is positive. For representative projects, i.e., projects that have the same risk as the overall firm, this rule can can often be simplified into discounting based on the cost of capital and investing in projects with positive NPV. We formalize this logic below and refer to additional discussion and extensions in the online appendix of Gormsen and Huber 2023.

Consider a manager who at time t considers a non-exclusionary investment opportunity i that generates the cash flow

$$C_{t+T}^i = \mu_i + \varepsilon_{t+T}$$

in T periods, where ε_{t+T} is unknown at time t. Undertaking the investment costs $\zeta_t^i > 0$ today. In the absence of frictions, the manager maximizes stock prices by choosing the project only if

$$E_t[M_{t+T}C_{t+T}^i] - \zeta_t^i \geq 0, \tag{A1}$$

where M_{t+T} is the stochastic discount factor. We can rewrite (A1) as

$$\mathbb{E}_t[\text{Return}_{t+T}^i] \geq R^f - \text{cov}\left(M_{t+T}, \text{Return}_{t+T}^i\right) R^f \tag{A2}$$

where R^f is the gross risk-free rate and $\text{Return}_{t+T}^i = C_{t+T}^i/\zeta_t^i$ is the return the firm earns on the invested capital. If the stochastic discount factor is driven by a factor model,

$$M_{t+T} = a_t - \sum_k b_t^k f_{t+T}^k,$$

we can rewrite (A2) as,

$$\mathbb{E}_t[IRR_{t+T}^i] \geq \lambda_{t,t+T}^0 + \sum_k \beta_t^k \lambda_{t,t+T}^k, \tag{A3}$$

where β_t^k is the multivariate beta of factor k in a projection of the IRR on the risk factors, $\lambda_{t,t+T}^0$ is the return on a zero-beta portfolio, and $\lambda_{t,t+T}^k$ is the premium on the k'th risk factor between t and $t + T$.[A1]

The expression in (A3) says that managers should accept investments for which the expected return is higher than the expected return in financial markets for a project with similar risk. If the cash flows of the project are representative of the overall firm and the project has zero net present value (i.e., it is a marginal project), the required return is the the expected return on the firm's assets in the financial markets. The firm can therefore approximate the optimal investment decision for such a project by using the cost of capital as its discount rate and chose positive NPV projects.

Equation (A3) also shows that managers should use the expected return over the full horizon of the investment project. Since most corporate investment has fairly long duration, managers should therefore use the long-run expected returns as the basis of their discount rates.

[A1]See Cochrane (2001) for derivation.

Appendix C   Details on Measurement

We follow the data collection procedure established by Gormsen and Huber (2023). We extend that dataset by adding conference calls for all years from FactSet and for the years 2021 and 2022 from FactSet and Refinitiv.

Appendix C.1   Extraction of Paragraphs from Conference Calls

We access all calls held in English during the period January 2002 to December 2022 and available on the databases Refinitiv and FactSet. We download paragraphs from the calls that fulfill two criteria: first, they contain one of the terms "percent," "percentage," or "%" and second, they contain at least one keyword related to the cost of capital. The keywords are capital asset pricing model, cost of capital, cost of debt, cost of equity, discount rate, expect a return, expected rate of return, expected return, fudge factor, hurdle rate, internal rate of return, opportunity cost of capital, require a return, required rate of return, required return, return on assets, return on invested capital, return on net assets, weighted average cost of capital, weighted cost of capital. We also include abbreviations of the keywords in the search, for example, WACC. We identify roughly 110,000 paragraphs containing a keyword.

We match the firm name listed on the conference call to Compustat Global Company Keys by using a fuzzy merge algorithm, checking each match by hand. Ultimately, we link 93 percent of the paragraphs to a Compustat firm.

Appendix C.2   Guidelines for Manual Data Entry

With our data collection team, we read through each paragraph and enter relevant figures into tables. We record the following financial variables from the calls:
- discount rate
- hurdle rate
- hurdle premium over the cost of capital
- fudge factor over the cost of capital
- cost of debt
- weighted average cost of capital (WACC)
- opportunity cost of capital (OCC)
- cost of capital
- cost of equity
- required, expected, and realized internal rate of return (IRR)
- required, expected, and realized return on invested capital (ROIC)
- required, expected, and realized return on equity (ROE)
- required, expected, and realized return on assets (ROA)
- required, expected, and realized return on net assets

We do not record hypothetical numbers (e.g., "we may use a discount rate of x percent" or "imagine that we use a cost of capital of x") and figures given by someone outside the firm (e.g., an analyst on the call suggesting a specific cost of capital for the firm). The context of statements is often key, so automated text processing cannot easily replace human reading for this task. For instance, the abbreviation OCC may refer to the opportunity cost of capital but more often than not actually refers to Old Corrugated Cardboard, a term for cardboard boxes used in the transport and recycling industries.

We only measure discount rates when managers explicitly discuss them as part of an investment rule. This means, for example, that we do not record discount rates used to value firms' pension liabilities. We focus on discount rates and the cost of capital that represent investment rules of the firm, as opposed to specific figures related to individual projects. For instance, we do not record the interest rate for a particular bond issuance. The paragraphs in the data entry sheets are sorted by firm and date, which helps us to interpret statements from the same firm consistently. When managers list multiple discount rates (usually for different regions and industries), we enter the figures that are representative of most of the company's operations (e.g., U.S.figures for a U.S.company). We discuss all cases with multiple rates among the whole team.

Managers mostly discuss their after-tax discount rate and cost of capital. We note when managers refer to pre-tax discount rates and pre-tax cost of capital. We convert all observations into after-tax values in two steps. First, we estimate the average percentage point difference between after-tax and pre-tax observations, controlling for country-by-year fixed effects. Second, we then adjust the pre-tax values reported on the calls using this average difference.

Similarly, managers rarely mention a "levered" discount rate, which is used in return calculations that do not take into account all the capital used to finance the investment. We convert all levered observations into unlevered values. Again, we estimate the average percentage point difference between levered and unlevered observations, conditional on country-by-year fixed effects, and then adjust the levered values using this difference.

Managers sometimes specify a range rather than an actual value. We enter the average value in these cases. We do not record values when the range is very large or ambiguous. Managers sometimes give different realized returns depending on the time horizon (e.g., "we have achieved a 5 percent ROIC over the last five years and a 10 percent ROIC over the last ten.") We enter the most recent horizon for such cases. Realized returns referring to a previous episode unconnected to current years (e.g., "return in the 1990s") are not recorded.

Appendix C.3   Data Collection Team

A total of 23 research assistants contributed to the data collection. The average team size at any point was 7. The team members were: Alexandra Bruner, Ben Meyer, Cagdas Okay, Charlotte Wang, Chris Saroza, Daniel Marohnic, Esfandiar Rouhani, Henry Shi, Izzy Sethi, Jasmine Han, Jason Jia, Madeleine Zhou, Manhar Dixit, Meena Rakasi, Neville Nazareth, Rachel Kim, Rahul Chauhan, Rohan Mathur, Sanjna Narayan, Scarlett Li, Sean Choi, Sungil Kim, Tony Ma.

Before assistants begin the actual data collection, we teach them basic asset pricing and capital budgeting. Each assistant then reads roughly 2,000 paragraphs to train, which we check and discuss.

All paragraphs containing values for a perceived cost of capital and a discount rate were read at least twice by different assistants and outliers were checked by the authors to avoid errors. The research team met every week to discuss individual cases and to coordinate on consistent data entry rules.

Appendix D   Relating the Perceived Cost of Capital to Measures of Expected Returns: Extensions

This section contains additional analysis linking the perceived cost of capital to expected returns in financial markets. In Section Appendix D.1, we introduce a cost of capital factor and study its risk premia. In Section Appendix D.2, we study how the perceived cost of capital relates to a large set of risk factors, and in Section Appendix D.2.1 we study how it relates to the implied cost of capital.

Appendix D.1 The Cost of Capital Factor

We construct a cost of capital factor by sorting firms into different portfolios based on their perceived cost of capital. Each month, we assign each firm to portfolios based on the firm's market capitalization and its most recently observed perceived cost of capital. We assign firms to portfolios following the methodology of Fama and French (1993).

Table A3 reports the performance of this cost of capital factor. In column (1), we report the average spread in the perceived cost of capital between the long leg and the short leg of the factor. The average spread is a 0.4% monthly return, translating to an annualized spread of around 6%. This spread is stable over time, leading to tight standard errors.

In column (2), we report the average return to the cost of capital factor. The factor has earned 0.007% per month, which is statistically indistinguishable from zero and statistically different from the spread in the perceived cost of capital of 0.4% per month. The expected return on the factor is the spread in the perceived cost of equity, which need not be the spread in the perceived cost of debt. However, we find that the spread in the perceived cost of debt is smaller than the spread in the perceived cost of capital, which means the spread in the perceived cost of equity must be even larger than the spread in the perceived cost of capital. The test therefore implies that the spread in the perceived cost of equity is not an unbiased predictor of future realized returns.

In columns (3) and (4), we control for the market, size, and value factors. These regressions represent an alternative approach to studying whether the factors are represented in the perceived cost of capital. These regressions reveal whether returns on firms with higher cost of capital behave more like, for instance, returns on small or large firms. The results generally confirm the findings from the characteristics-based analysis in Section 2. Namely, firms with higher cost of capital have higher market betas, smaller size, and higher valuation ratios. However, the evidence for the value effect is now substantially stronger than when looking at the characteristics. In fact, the loading on the value factor is higher than the loading on the market factor and as high as the loading on the size factor. The loading is also highly statistically significant. One potential interpretation of these findings is that there is an economically important difference between characteristics and factor loadings, as first pointed out by Daniel and Titman (1997).

Appendix D.2 Perceived Cost of Capital in the Factor Zoo

In addition to the Fama-French characteristics analyzed in Section 3.2, the asset pricing literature has uncovered hundreds of other factors that could influence the cost of equity and thereby the cost of capital. In this section, we conduct an initial exploration of these other factors. The main takeaway is that most factors are not reflected in the perceived cost of capital and, to the extent that they are, often have the wrong sign.

We consider all factors identified by Jensen et al. (2023). For each factor k, we extract factor premia from slope coefficients in the regression

$$r_{i,t}^{\text{cost of capital}} = b^0 + b^1 X_{i,t}^{\text{beta}} + b^2 X_{i,t}^{\text{lev}} + b^3 X_{i,t}^{\text{lev squared}} + b^4 X_{i,t}^k + \varepsilon_{i,t}^k, \tag{A4}$$

where, as before, $r_{i,t}^{\text{cost of capital}}$ is the perceived cost of capital of firm i at time t, $X_{i,t}^k$ is the characteristic associated with the k$^{\text{th}}$ factor, and b^k is the parameter estimate for the k$^{\text{th}}$ characteristic. The specification thus studies each characteristic k separately, controlling for the CAPM beta, leverage, and leverage squared. We control for the CAPM beta because the equity factors we study are associated with positive CAPM alpha, not necessarily positive expected returns. We control for leverage to account for the mechanical effect of leverage on the cost of capital. We consider the

factors in univariate specifications, only conditioning on the above controls, as these factors have typically been studied in univariate specifications.

To create an overview, we categorize the factors into the groups proposed by Jensen et al. (2023) and study average properties across groups. There are seven groups of factors based on well-known major drivers of stock returns: value, profitability, investment, trading frictions, intangibles, momentum, and a final group called "new", which captures a range of recent factors.

Table A2 reports results averaged across the different factor groups. We sign all factors such that a higher factor is associated with a higher monthly CAPM alpha in financial markets. The first column reports the average factor premium in the group. For the group of value factors, the average premium is around 0.25 percentage points. While substantially smaller than the beta and size premia established in Table A1, it is larger than the average risk premium in any other factor group, most of which are either close to zero or negative.

The next column shows the percentage of the factors in a given group that have the correct sign. We see that a reasonable fraction of the factors based on value and trading frictions have premia with the correct sign (66% and 67%). The other groups produce factors that consistently have the correct sign (intangibles is close to 50%).

The last column shows the percentage of the factors in a given group that have the correct sign and are statistically significant. That is, for each factor, we test whether the factor loading is equal to zero against the one-sided alternative that it has the same sign as observed in financial markets (i.e., whether the coefficient positive). To give the factor the best possible chance, we consider a factor to be statistically significant if it has a p-value below 5% in the one-sided test using conventional OLS errors. We correct for the number of factors tested within a group using the Benjamini and Hochberg (1995) method and setting a false discovery rate at 5% (this is lenient once again relative to, for instance, a Bonferroni adjustment).

Despite the arguably generous method for assessing significance, we find that most groups do not have many significant factors. Only a handful of factors are significant in the value, trading friction, intangible, and profitability groups. None of the factors in the investment, new, and momentum groups are significant with the correct sign.

The last row of Table A2 summarizes all factors. Overall, the average factor premium across the 146 factors tested is zero and less than 50% of the factors have the correct sign. Moreover, only 9% of the factors have premia with the correct sign that are statistically significant. Overall, these results leads us to conclude that the majority of factors studied in the asset pricing literature are not reflected in firms' perceived cost of capital. Complementary recent work also shows that most factors do not affect subjective return expectations of financial analysts (Engelberg et al. 2020, Jensen 2022).

Finally, many of the investment factors have the wrong sign. This represents a serious challenge for the Investment CAPM and production-based asset pricing more generally, as discussed in Section 6.

Appendix D.2.1   Perceived Cost of Capital and the Implied Cost of Capital

A large literature in finance and accounting uses present value accounting to back out the expected long-run returns on individual firms. In particular, by combining measures of expected future cash flows with current prices, one can calculate the implied discount rate for a firm, and thereby an "implied cost of capital" (Gebhardt et al. 2001, Botosan and Plumlee 2002, Mohanram 2003). It has been debated whether measures of the implied cost of capital predict future stock returns (Easton and Monahan 2005). Independently of their predictive power for stock returns, it is possible that

these measures predict the perceived cost of capital, in particular if firms use valuation ratios and present value accounting in estimating their perceived cost of capital.

Throughout, we present results for the implied cost of capital using the price-earnings growth model in Easton and Monahan (2005), but we find similar results using alternative measures. The pure implied measures actually capture the implied cost of equity, not the full cost of capital. We additionally calculate the implied cost of capital based on the firm's leverage ratio and the proxy for cost of debt used in the above sections.

Panel A of Table ?? reports firm-level panel regressions of the perceived cost of capital on the implied cost of equity or the implied cost of capital. The first column shows a positive relation between the perceived cost of capital and the implied cost of equity. If the perceived cost of capital and the implied cost of equity were both unbiased predictors of expected stock returns, the slope coefficients in these regressions would roughly equal the equity financing share of firms (around 2/3). However, the estimated coefficients are well below that, both in the baseline that uses only country fixed effects and in regressions that include year (column 2) and firm fixed effects (column 3).

In column (4) through (6), we use the implied cost of capital on the right-hand side. The slope coefficient should be 1 if the implied cost of capital, on average, accurately predicts the perceived cost of capital. We strongly reject this prediction. The slope coefficients are between 0.05 and 0.07 and the within-R^2 is modest in all specifications.

The results in Panel A of Table ?? suggest that there are substantial wedges between the perceived and implied cost of capital. To illustrate the magnitude of these wedges, we sort firms into ten portfolios based on the implied cost of capital for a given firm in a given quarter. We then average the implied and perceived cost of capital across firms in these portfolios. Figure ?? shows the averages along with wedges, which are defined as the difference between the average perceived cost of capital of firms in the portfolio and the average implied cost of capital of firms in the portfolio.

The implied cost of capital increases from around 6% to 20% when going from the portfolio with the lowest to the highest implied cost of capital. The perceived cost of capital is, however, essentially the same for all portfolios. As a result, we observe large wedges across the ten portfolios. For the portfolio with the highest implied cost of capital, we find that the wedge is above 11%, substantially exceeding the average cost of capital.

Taken together, the results suggest that measures of the implied cost of capital do not accurately capture firms' perceived cost of capital. As a result, the implied cost of capital may not be a suitable measure for researchers interested in testing how economic shocks influence the cost of capital that firms use to guide their capital allocation and investment decisions. In the final section of the paper, we introduce a new measure of the perceived cost of capital that can be used in applied work going forward.

Appendix E   Can "As if" Behavior Save the Investment CAPM?

One may be tempted to rationalize the results on the Investment CAPM without rejecting the model by invoking an "as if" argument. The argument could be that low-investment firms do not explicitly articulate that they have a high cost of capital, but instead they implicitly know that they should require a high return on their investments. For instance, these firms may perceive that they face substantial risks, which then causes managers to require a higher return on new investments. Under this argument, firms behave "as if" they had a high perceived cost of capital. The argument could in principle be correct because many firms indeed maintain discount rates (i.e., required returns on new investment) that differ from their perceived cost of capital (Graham and Harvey 2001, Gormsen and Huber 2023).

Fortunately, we can directly test this hypothesis because the conference call data also contain firms' discount rates. In Table A4, we reproduce the regressions of Table 5, except we now use the firm-level discount rate on the left-hand side. The cross-sectional relation between the investment rate and discount rates is also positive and significant when we only condition on profitability (in column 2). These results suggest that high-investment firms do not behave "as if" they have low discount rates.

It is important to emphasize that a firm's discount rates is negatively related to investment, once one conditions on the investment opportunities available to firms (i.e., once one includes more controls than just the return on equity used above). Indeed, Gormsen and Huber (2023) show that, conditional on firm fixed effects, discount rates negatively predict future investment in a manner that is quantitatively consistent with a simple Q-model. More generally, the above results are not a rejection of the idea that the cost of capital raises discount rates and, ultimately, lowers investment. However, the results reject the specific Investment CAPM formulated by Hou et al. (2015), which requires that discount rates and the perceived cost of capital are negatively correlated with investment only conditioning on profitability.

Appendix F   Details on the "Implied Cost of Capital"

We consider four different measures of the implied cost of capital from the accounting literature. These measures are the residual income models of Gebhardt et al. (2001) and Claus and Thomas (2001) and the dividend discount models of Easton (2004) and Ohlson and Juettner-Nauroth (2005). We average across the four measures to get a final estimate of the implied cost of capital.

We use data from Eskildsen et al. (2024) on the four measures of the implied cost of capital.[A2] The data predict future realized stock returns with a slope coefficient of 0.5 in a broad global sample.

Appendix G   Construction of Predicted Data

In Section 3.3, we estimate a simple empirical model to summarize the perceived cost of capital. On the basis of this model, we construct a series of predicted value of the perceived cost of capital for the universe of firms for which we observe the required characteristics. In this section, we explain the process through which we construct the predicted value. We also conduct a similar exercise for firms' discount rates. The predicted data can be found on costofcapital.org along with additional details on the estimation.

Appendix G.1   A Multivariate Model of Discount Rates

We follow the procedure in Section 3.3 to estimate a similar model for firms' discount rates.

The Lasso procedure picks 13 variables for predicting discount rates. These variables are illustrated in Figure A1, which is discussed below. The in-sample R^2 of the selected model is 16%.

Figure A1 shows the slope coefficients for each of the 13 selected variables. These slope coefficients directly tell us how much the predicted value of the discount rate increases if we go from the bottom to the top of the cross-section of the given characteristics (keeping the other 12 characteristics constant). The most important characteristic is idiosyncratic volatility, which is measured over 252 days relative to the CAPM (see Jensen et al. 2023 for formal definitions). The coefficient is 3.2, which means that the perceived cost of capital is predicted to be 3.2 percentage points higher for the firms with the highest volatility relative to those with the lowest volatility. The second most important

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[A2]We thank Theis Jensen for sharing data.

characteristic is age. The coefficient shows that the oldest firms in the economy have roughly 2 percentage points lower hurdle rates than the youngest firms. The next variable is cash-to-assets. Firms with more cash have higher hurdle rates. Firms with higher labor force efficiency and lower risk of default (higher Z-score) also have higher hurdle rates. Discount rates are lower for firms with abnormally high investment. This last finding is consistent with the idea that lower hurdle rates leads to higher investment.

Appendix G.2   Generating Predicted Data

We construct predicted values of firms' perceived cost of capital and discount rates based on the models in Sections 3.3 and Appendix G.1.

Based on the model estimated by the Lasso procedure, we calculate predicted values for all firms for which we observe the set of characteristics needed to calculate both perceived cost of capital and discount rates. Since we only feed the model cross-sectional predictors, there is virtually no time variation in the aggregate series. To obtain the correct time variation, we add in the estimated time variation from the full sample of discount rates and perceived cost of capital. We estimate the time variation in these objects by projecting discount rates and perceived cost of capital onto year dummies and absorbing firm fixed effects. This procedure ensures that all variation is driven by within-firm variation in the relevant estimates and it follows the procedure in Gormsen and Huber (2023). We calculate time variation separately in the US and Europe. The European countries consists of both euro (or euro-pegged) countries as well as the UK, in which firms denominate in pounds. Using only one time series for euro and pound denominated series could be problematic in the presence of large divergence in inflation across the two currencies, but it helps ensure a sufficient set of firms to estimate time variation robustly. We exclude firms from other countries from our sample of predicted values as we do not have enough observations to robustly estimate the time variation.

The analysis of discount rates are for what we refer to as headquarter discount rates. Gormsen and Huber (2023) discuss how firms use higher discount rates at the subsidiary level than the headquarter level to account for overhead costs. The analysis and predicted values are for the discount rates are for headquarter discount rates.

Appendix G.3   Validation

We validate the predictive power of our data in an out-of-sample test. In this test, we use the predicted values to predict the perceived cost of capital and discount rates observed in the Duke-CFO survey. The seminal Duke-CFO survey is a quarterly survey of corporate managers (Graham and Harvey 2001). In some of these surveys, managers are asked about their cost of capital and their discount rates (referred to as hurdle rates in the survey). We use these data to test how well our predictive value work out of sample.[A3]

The results are presented in Table A5. The first two columns shows regressions of the perceived cost of capital in the Duke-CFO data on the predicted values. The slope on the predicted values is 0.74 without year fixed effects and 0.9 with year fixed effects. These results are consistent with the notion that the time variation in the perceived cost of capital in the Duke-CFO survey differs from that of the conference call data (see Gormsen and Huber 2023 for more discussion on this result), so including year fixed effects to capture this difference increase the slope. More importantly, the finding in column 2 suggests that the cross-sectional variation in our predicted values is also in the

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[A3]We thank John Graham for generously sharing these data.

Duke-CFO data with the same magnitude (slope close to 1). The cross-sectional variation in the predicted values thus appears to be an unbiased predictor of the cross-sectional variation in the Duke-CFO data.

Column three and column four shows results for discount rates. Here the slope coefficients are almost exactly one, both with and without year fixed effects. The discount rates in the Duke-CFO data are around three percentage points higher than in the conference call data, as seen from the intercept. A likely driver of this difference is that our predicted data is for headquarter discount rates, which are lower than non-headquarter discount rates, whereas the the Duke-CFO data likely contain a mix of headquarter and non-headquarter discount rates. It should, however, be noted that the three percentage point difference is insignificant given the small sample of 92 observations.[A4]

[A4]While the Duke-CFO data contains more than 92 observations, many of these are non-listed firms or firms that cannot be matched to firm-level identifiers.