Corporate Discount Rates*

Niels Joachim Gormsen and Kilian Huber

July 2022

Abstract

Standard theory implies that the discount rates used by firms in investment decisions play a key role in determining investment and in transmitting shocks to asset prices and interest rates to the real economy. However, there exists little evidence on how corporate discount rates change over time and affect investment. We construct a new global database of firms' discount rates based on manual entry from earnings conference calls. We show that corporate discount rates move with the cost of capital, but the relationship is less than one-to-one, leading to time-varying wedges between discount rates and the cost of capital. The average discount rate wedge has increased substantially over the last decades as the cost of capital has dropped. Discount rate wedges are negatively related to future investment, with a magnitude close to that predicted by theory. Moreover, the large and growing discount rate wedges can account for low investment (relative to high asset prices) in recent decades. We find important roles for risk and market power in explaining levels and trends in discount rate wedges.

*We are extremely grateful to Nicolas Crouzet and Emanuele Colonnelli for sharing code and comments. We also thank Janice Eberly, Ravi Jagannathan, Anil Kashyap, Ralph Koijen, Christian Leuz, Robert L. McDonald, Brent Neiman, Lubos Pastor, Lasse Pedersen, Monika Piazzesi, and many seminar participants for helpful comments. This research was supported by the Asness Junior Faculty Fellowship, the Becker Friedman Institute, the Fishman Faculty Research Fund, and the Fama-Miller Center at the University of Chicago. Valerii Baidin, Alexandra Bruner, Rahul Chauhan, Sean Choi, Jason Jia, Sungil Kim, Scarlett Li, Tony Ma, Daniel Marohnic, Ben Meyer, Neville Nazareth, Cagdas Okay, Prithvi Pahwa, Esfandiar Rouhandi, Chris Saroza, Sixun Tang, and Madeleine Zhou provided outstanding research assistance. Both authors are at the University of Chicago, niels.gormsen@chicagobooth.edu and kilianhuber@uchicago.edu.

Discount rates play a crucial role in firms' investment decisions. By setting their discount rate, firms determine how much they value future cash flows generated by an investment. If firms choose lower discount rates, firms value future cash flows more and therefore invest more. In theory, the effect of discount rates on investment can be large. A standard Q-model, for instance, predicts that a drop in the discount rate of 1 percentage point raises firm investment by 25 percent.[1]

Despite the importance of firms' discount rates, there exists little evidence on how discount rates change over time and how they affect investment, mainly because discount rates are not directly observed. The stylized view is that firms passively adopt the cost of capital from financial markets as their discount rate. In practice, however, discount rates may vary substantially from the financial cost of capital for multiple reasons. First, the financial cost of capital is difficult to estimate, leading to wedges between firms' perceived cost of capital and the true financial cost of capital. Second, firms deliberately add wedges to their to their perceived cost of capital when choosing discount rates, as shown in previous surveys (Poterba and Summers 1995, Jagannathan et al. 2016, Graham 2022). Firms' choices of discount rates are therefore likely to deviate substantially from the financial cost of capital.

In this paper, we construct a new dataset to study how firms' discount rates change over time and relate to investment. The dataset contains information on discount rates and the perceived cost of capital for 2,400 firms, including many of the world's largest corporations. We show that firms' perceived cost of capital, on average, reflects variation in the financial cost of capital close to one-to-one. However, firms only partially incorporate changes in their perceived cost of capital into discount rates, leading to large and time-varying wedges between discount rates and the cost of capital. The average discount rate wedge has increased substantially over the last decades as the cost of capital has decreased while discount rates have remained more stable. We find that firm investment is strongly related to discount rate wedges and that the trend in the average wedge is important for understanding aggregate investment dynamics in recent decades.

We measure firms' discount rates and perceived cost of capital using corporate conference calls. The majority of listed firms hold conference calls every quarter, so that managers can inform financial analysts and investors about their firms' operations. On these calls, managers sometimes reveal their firms' discount rates and their perceived cost of capital as a way of providing transparency to their investment decisions.[2] We collect transcripts

[1] For this calculation, we adopt the capital adjustment cost specification from Philippon (2009), assume a duration of Tobin's Q of 25 years, and calculate the investment effect at the model's steady state.

[2] The discount rate is the rate at which the firm values future cash flows and which enters the net present

for conference calls between 2002 and 2021 and identify 55,000 paragraphs where managers discuss their discount rates or cost of capital. We read through each paragraph with a team of research assistants and manually extract relevant information.

The product of this data collection effort is a large global database of firms' discount rates and perceived cost of capital, matched to investment rates. The data contain observations for roughly 2,400 firms across 20 countries. A unique feature of the data is that we can study variation in discount rates and investment across time within firms and countries. We observe discount rates and the perceived cost of capital for 19 sequential years across multiple countries, giving rise to a country-level panel; and we observe many firms multiple times, giving rise to a firm-level panel. This panel variation is new to the literature and key to understanding how discount rates and the cost of capital relate to one another and to investment.

We start analyzing the new dataset by relating firms' perceived cost of capital to the cost of capital on financial markets. The cost of capital is the weighted average cost of debt and equity. Firms can approximate the financial cost of debt using bond yields and interest rates. It is thus not surprising that the financial cost of debt in a given country is closely associated with the cost of debt perceived by firms. However, to calculate the cost of equity, firms need to estimate expected stock returns, which is not straightforward (Fama and French 1997, Jagannathan et al. 2017). MBA students are often taught simplified approaches, for example to assume a constant equity risk premium, which would lead to mistakes in the perceived cost of equity (Cochrane 2011). Nonetheless, we find that firms' perceived cost of capital incorporates variation in expected stock returns. Overall, the perceived cost of capital increases by 0.8 percentage points when the financial cost of capital increases by 1 percentage points. There is, however, substantial heterogeneity in perceptions across firms.

We next study how discount rates relate to the perceived cost of capital. We confirm the existing finding that discount rates are substantially higher than the cost of capital, on average twice as large. More importantly, we find that changes in the cost of capital are incorporated into discount rates, but the relationship is significantly below the one-to-one mapping implied by theory. Using methods robust to attenuation bias, we find that a 1 percentage point increase in the perceived cost of capital leads to a 0.4 percentage point increase in discount rates.

value (NPV) calculation. Managers often discuss discount rates in terms of minimum required returns, or hurdle rates, that the firm would accept on investments. For the marginal project, the minimum required rate of return is equal to the discount rate. We therefore use the terms discount rate, hurdle rate, and required internal rate of return interchangeably for the purpose of our data collection.

The imperfect relation between discount rates and the cost of capital gives rise to a time-varying wedge between discount rates and the cost of capital. For the US, this wedge has expanded substantially over the last two decades as the cost of capital has decreased while discount rates have remained relatively stable. Using within-firm variation, we find that the wedge has increased by around 2.5 percentage points between 2002 and 2021 for the average firm in our sample. An increase of this magnitude is likely to be important for our understanding of investment dynamics, which we turn to next.

We first explore how discount rates relate to investment. We find that time variation in discount rates is strongly negatively related to investment, both at the firm and country level. Average discount rates and aggregate investment in the US in the past two decades strongly comove. At the firm level, we find that a one percentage point increase in the discount rate lowers the investment rate by -0.8 points. This estimate is robust to controlling for firm and year fixed effects, Tobin's Q, the cost of capital, and other firm observables. We show that the magnitude is consistent with a simple Q-model where firms use our measured discount rates in investment decisions.

We next address how the large and increasing discount rate wedges influence our understanding of the relation between aggregate investment and pricing in financial markets. A recent literature argues that US investment has been low in recent decades relative to the falling financial cost of capital. In particular, declines in the financial cost of capital have raised firms' market value and thereby led to high and rising values of Tobin's Q. According to standard Q-theory, investment should have risen with Tobin's Q. However, if anything, observed investment rates have been low relative to historical standards, leading researchers to argue that there is "missing investment" summing to more than 10 percent of the capital stock (Gutiérrez and Philippon 2017, Alexander and Eberly 2018).

We find that the evolution of discount rate wedges can account for a large part of the decoupling between Tobin's Q and investment over the sample. Intuitively, the large and increasing discount rate wedges imply that firms are holding back investment relative to what the financial cost of capital would suggest. To make this point precise, we develop an "adjusted Q," which accurately captures firms' investment demand in the presence of discount rate wedges. Using the adjusted Q, we find that the increase in discount rate wedges over the last decades is large enough to account for most of the "missing investment". This finding does not imply that discount rate wedges explain "missing investment." Rather, it suggests that investigating the drivers of discount rate wedges is useful for our understanding of why investment appears lower than suggested by financial markets.[3]

We discuss and test multiple theories of why discount rate wedges vary across firms and time. We consider three theories of cross-sectional variation in wedges, namely, theories related to market power, risk, and financial constraints. Market power may influence wedges because the lack of competitive pressures allows firms to maintain discount rates well above their financial cost of capital. Risk may influence wedges through multiple channels. First, firms may add wedges to their financial cost of capital if new projects are riskier than existing ones. Second, real options theory suggests that firms with irreversible investment should postpone investments in the face of increased risk and uncertainty (see e.g. Abel and Eberly 1996), which can lead riskier firms to use higher discount rates (McDonald 2000). Finally, the shadow cost of financial and managerial constraints may generate wedges on top of the financial cost of capital (Jagannathan and Meier 2002). We find that measures of market power, risk, and financial constraints all have substantial power in explaining cross-sectional variation in discount rate wedges.

We also consider drivers of time variation in discount rate wedges. We find a strong role for market power. In particular, we find that firms with high market power have kept their discount rates high over the last decades, despite the falling financial cost of capital. Firms without market power have, in contrast, decreased their discount rates almost one-to-one with the cost of capital. This pattern is consistent with the idea that many managers are averse to lowering their discount rates – due to agency issues and behavioral biases – and need competitive pressure to do so. Competitive pressure forces firms with low market power to decrease their discount rates as the financial cost of capital decreases. Firms with high market power, on the other hand, are free to keep their discount rates high as the cost of capital falls. We also find that evidence that time variation in risk influences discount rate wedges through the real options channel, meaning that secular increases in uncertainty (Baker et al. 2016) may have contributed to the increase in discount rate wedges as well.

Related Literature

Firms' cost of capital and discount rates have long been thought to play a prominent role in understanding investment dynamics both among academics (e.g., Jorgenson 1963, Tobin

[3]The behavior of discount rate wedges also shed light the sensitivity of investment to respect to the financial cost of capital. We show that discount rate wedges lower the sensitivity of investment up to a factor of five in a simple Q-model. The dampening impact of wedges may help to explain why macroeconomic models that abstract from such wedges need to assume sizable adjustment costs to match the investment elasticities estimated by, for example, Gilchrist and Zakrajšek (2012) and Zwick and Mahon (2017).

1969, Barro 1990, Cochrane 1991, Gilchrist and Zakrajšek 2012, Hall 2017, van Binsbergen and Opp 2019) and policymakers (Cieslak and Vissing-Jørgensen 2021). We provide the first dataset that links firms' discount rates and perceived cost of capital to investment. Based on these data, we present evidence that discount rates indeed change with the cost of capital and influence investment. But we also document substantial wedges that impact the relationship between discount rates, investment, and pricing on financial markets.

For the cost of capital to affect investment, three conditions must hold: (1) firms must incorporate the financial cost of capital into their perceived cost of capital, (2) the perceived cost of capital must affect discount rates, and (3) discount rates must influence investment. The literature offers several reasons why this chain may not operate as neatly as theory suggests. First, the financial cost of capital is difficult to estimate for rational agents (Fama and French 1997, Pástor and Stambaugh 1999, Welch and Goyal 2008) and even more so for behavioral actors (Greenwood and Shleifer 2014). Second, firms might choose discount rates that differ from the financial cost of capital, either because they believe there is mispricing in financial markets (Stein 1996) or to account for idiosyncratic risk (Dixit and Pindyck 1994, Abel and Eberly 1996, McDonald 2000, Décaire 2021). Consistent with these views, Sharpe and Suarez (2021) report survey evidence that some managers do not intend to adjust their discount rates when interest rates change. Finally, managerial considerations apart from net present value might play a role in practice, unlike in simple models (Graham 2022). We contribute by providing direct evidence on each of these three conditions, allowing us to evaluate their empirical relevance.

Our results also inform a large literature that studies how pricing on secondary asset markets influences real outcomes (see the review in Bond et al. 2012). For instance, Krüger et al. (2015) and Dessaint et al. (2021) study how wedges between perceived and financial cost of capital cause real distortions; Pflueger et al. (2020) argue that pricing of risk in financial markets influence the cost of capital and investment; and a large literature in asset pricing explains equity anomalies based on the assumption that firms invest based on expected stock returns (Zhang 2005, Hou et al. 2015, Gomes et al. 2003, Hennessy et al. 2007).

Existing evidence on firm discount rates comes from surveys. Summers (1986) reports discount rates for 95 firms in 1986, Poterba and Summers (1995) for 160 firms in 1990, and Jagannathan et al. (2016) for roughly 100 firms in 2003. The influential Duke CFO Survey provides broad insights into the practice of corporate governance (Graham and Harvey 2001). The survey has asked firms about their discount rates on five occasions between 2011 and 2019 (Graham 2022); around 130 observations of discount rates and 330 estimates of the perceived cost of capital are linked to financial data for listed firms. Our new dataset contains panel data on discount rates, the perceived cost of capital, and investment for 2,400 listed firms. This allows us to conduct dynamic within-firm analyses and to shed light on investment puzzles.

A further feature of the new data is that we can directly observe how firm-level changes in the financial cost of equity affect firms' perceived cost of equity, discount rates, and ultimately investment. Previous research documents that discount rates are related to both the perceived and financial cost of capital (Jagannathan et al. 2016, Gormsen and Huber 2022) in the cross section. The new data allow us to further address dynamic relations over time and the effects on investment.

1 Conceptual Framework

Most investment projects incur costs today and are expected to earn revenue in the future. When deciding whether to undertake a project, firms therefore need to compare the value of different cash flows across time. The standard approach in economics and finance assumes that firms calculate the net present value (NPV) of projects and invest only in projects with positive NPV:

$$\text{NPV}_t = \sum_{s=0}^{S} \delta_t^{-s} (\text{Revenue}_{t+s} - \text{Cost}_{t+s}), \tag{1}$$

where Revenue_t and Cost_t are cash flows at time t and δ_t is the discount factor for time t. The discount factor measures how much firms value cash flows in a future period t relative to today. When firms adjust their discount factor, the number of projects with positive NPV and total investment change (keeping cash flows fixed).

In typical stylized models, economists assume that firms only use their financial cost of capital to inform their discount factors. This financial cost of capital reflects both the time value of money and the riskiness of the firm's assets. The stylized assumption is that:

$$\begin{aligned} \delta_t &= 1 + r_t^{\text{fin}} && (2) \\ &= 1 + \omega_t \times (1 - \tau) \times r_t^{\text{debt}} + (1 - \omega_t) \times r_t^{\text{equity}}, && (3) \end{aligned}$$

where r_t^{fin} is the financial cost of capital. It is defined as the weighted average cost of debt and equity (WACC), where r_t^{debt} and r_t^{equity} are the cost of debt and equity, τ is the firm's tax rate, and ω_t is the leverage ratio (i.e., the market value of debt relative to the market value of debt plus equity). The stylized assumption is based on the idea that the financial cost of capital is the optimal discount rate if firms want to maximize their market value, as long as the project under consideration carries the same risk as the firm's existing investments.[4]

In standard models, firms passively take their discount rate as given. However, in practice, firms need to actively calculate and set discount rates. Two internal processes within firms may cause discount rates to diverge from the financial cost of capital. First, firms cannot directly observe the financial cost of capital, but have to estimate it. Estimating long-run expected stock returns is difficult (Fama and French 1997, Pástor and Stambaugh 1999, Campbell and Thompson 2008) and practitioners are often taught simplifying assumptions (like a constant equity risk premium of 6 percent, Cochrane 2011). The cost of debt is easier to calculate, but still needs to be estimated based on bond prices and assumptions about default risk. These factors make it likely that firms' perceived cost of capital differs from the financial cost of capital. We define a "cost of capital wedge," called υ. The perceived cost of capital is the financial cost of capital plus υ:

$$r_t^{\text{per.}} = r_t^{\text{fin.}} + \upsilon_t. \tag{4}$$

In a second internal process, firms decide how to incorporate their perceived cost of capital into their discount rate. Existing surveys suggest that firms use discount rates that are substantially above the perceived cost of capital (Poterba and Summers 1995, Jagannathan et al. 2016, Graham 2022, see discussion in Section 5 for potential motives). We define the "discount rate wedge," κ_t, as the difference between the discount rate and the perceived cost of capital. This leads to the following expression:

$$\begin{aligned} \delta_t &= 1 + r_t^{\text{per.}} + \kappa_t & (5) \\ &= 1 + r_t^{\text{fin.}} + \upsilon_t + \kappa_t, & (6) \end{aligned}$$

which says that the discount rate differs from the financial cost of capital both because of the cost of capital wedge and the discount rate wedge.

[4] If project risk differs, the optimal discount rate is project-specific. However, if a firm on average carries out new projects that are in line with its existing ones, the average discount rate should still be close to the financial cost of capital.

2 Measurement

Firms' discount rates and perceived cost of capital are not observed in publicly available reports. We construct a new dataset that measures listed firms' discount rates and perceived costs of capital, equity, and debt. Importantly, we combine these figures with measures of the financial cost of capital and firm investment, allowing us to shed light on how firms' internal decisions comove with capital markets and real outcomes.

2.1 Extracting Paragraphs from Conference Calls

Our measurement relies on transcripts of corporate earnings conference calls. The majority of listed firms hold conference calls every quarter, so that managers can inform financial analysts, investors, and other observers about the firm's strategy (Frankel et al. 1999, Hassan et al. 2019). We download all transcripts of conference calls for the period January 2002 to September 2021 available on the Thomson One database. We identify paragraphs that contain at least one keyword as well as one of the terms "percent," "percentage," or "%".[5] Details on the data extraction are in Appendix B.

It is difficult to train an algorithm to recognize discount rates and the perceived cost of capital from managers' transcripts, as context and background are of the essence. Instead, we rely on manual data entry. We trained a team of research assistants to identify and record the relevant figures from the text. Overall, the team read 74,000 distinct paragraphs over the span of roughly 2 years.

2.2 Identifying Discount Rates and the Cost of Capital in Conference Calls

The discount rate defines the rate at which a firm values future cash flows. An equivalent interpretation is that a discount rate measures the lowest internal rate of return (IRR) that a firm is willing to accept on its investments (also know as hurdle rate). To see the equivalence, note that the expected rate of return on a project equals the discount rate if the NPV is zero and exceeds the discount rate if the NPV is positive. As a result, if a firm's rule is

[5]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, IRR.

to invest in projects where NPV is above zero, it equivalently chooses only projects where the expected return exceeds the discount rate. For the purposes of our measurement, the terms discount rate, minimum IRR, and hurdle rate all capture the same concept (see also Jagannathan et al. 2016).[6]

There are three ways in which we identify discount rates. First, managers often state the required IRR for future investment projects. We only interpret an IRR as discount rate if it clearly refers to a required minimum rate as part of an investment rule. We separately record realized IRRs, when managers talk about current performance, and expected IRRs, when managers predict future performance without setting an explicit investment rule. Second, we interpret hurdle rates as discount rates if they are calculated on the basis of an IRR. Finally, managers sometimes define a discount rate based on a hurdle premium or fudge factor, which are added to the cost of capital. To ensure that we differentiate between discount rates and other rates, we record a range of additional variables from the conference calls, including required, expected, and realized returns on assets, on invested capital, and on equity.

To measure the perceived cost of capital, we study paragraphs where managers state their costs of equity, debt, and capital. These figures come from firms' internal calculations, potentially relying on prices on capital markets and interest rates. We also consider abbreviations (e.g., WACC) and synonyms (e.g., required return on equity) as long as managers clearly relate them to financing costs.

2.3 Practical Measurement Guidelines

We begin with an example from a conference call held by the S&P 500 firm Air Products and Chemicals on September 17, 2015:

"Our weighted average cost of capital for the company (...) is 8 percent. (...) We are not going to do any project which has a less than a 10 percent internal rate of return. (...) We have established a minimum hurdle rate of 10 percent internal rate of return for all new projects."

From this paragraph, we record that the firm's perceived cost of capital was 8 percent

[6] In line with standard theory, finance textbooks recommend that firms should make investment decisions using NPV. In practice, around 80 percent of firms follow this recommendation, according to surveys presented in Trahan and Gitman (1995), Graham and Harvey (2001), and Graham (2022). The second most common method involves comparing a project's IRR to the minimum IRR.

and its discount rate 10 percent, implying that the discount rate wedge $\kappa_t = 2$.

We detail the measurement guidelines in Appendix B. To summarize, we generally record only contemporaneous measures stated by firm managers and exclude figures that are historical, speculative, or posited by outsiders. A handful of firms mention multiple discount rates, for example, varying by country. We record the rate that represents most of the firm's operations (e.g., the US discount rate for a firm with operations mainly in the US). We restrict the data collection to figures representative for the firm overall. For instance, if the manager of a mining company refers to the cost of debt from a particular bond issuance, we do not record the figure.

To ensure high quality and consistency across research assistants, we had weekly team meetings where we discussed specific paragraphs. Many paragraphs were read by two separate research assistants to ensure consistent entries across research assistants. All outlier observations (in levels and changes) for discount rates were checked by hand by the authors.

2.4 Measuring the Financial Cost of Capital

We amend the data from conference calls with the financial cost of capital. The cost of capital is the weighted average cost of debt and equity (equation 3). The cost of debt is calculated as the after-tax expected return on the firm's debt. The cost of equity, which is the long-run expected stock return, is more complicated to calculate. At the firm level, the cost of equity is calculated as the country-level cost of equity adjusted for the firm's relative riskiness. Below, we first explain how we estimate country-level cost of equity before explaining how we calculate the firm-level cost of equity. We note that estimating the firm-level cost of equity is associated with more uncertainty as it incorporates both uncertainty about the country-level cost of equity and the firm-level risk adjustment.

2.4.1 Financial Cost of Capital at the Country Level

We calculate the expected average equity return based on the balanced growth model. For each country in our sample, we calculate average 5-year earnings (based on all firms listed in the country) and compare these trailing five-year earnings to the total market capitalization to obtained the earnings yield.[7] In the balanced growth model, long-run expected equity

[7] In the US, we use the inverse of the CAPE ratio maintained by Robert Shiller as the earnings yield. We shrink the earnings yield towards the tim-series mean in each country outside the US by a Shrinkage factor of 0.5.

returns are:

$$r_t^{\text{equity, country}} = \frac{\text{Earnings}_t}{\text{Price}_t} + g_t. \tag{7}$$

We approximate g_t as 2 percent plus average inflation over the last two years.[8] We approximate the cost of debt using the long-run (10 year) yield on government debt from the OECD and assuming a tax rate of 20 percent.

The country-level financial cost of capital is the average cost of debt and equity, weighted by average leverage in the country.

2.4.2 Financial Cost of Capital at the Firm Level

We use the Capital Asset Pricing Model (CAPM) to estimate the firm-level cost of equity. While the CAPM model does not fully explain long-run expected stock returns (Fama and French 1992), it is the model most commonly used by practitioners. The model says:

$$E_t^{\text{CAPM}}[r_t^{\text{equity, firm}}] = r_t^f + \beta_t^{\text{firm}} \lambda_t, \tag{8}$$

where r_t^f is the risk-free rate, β_t^{firm} is the market beta of the firm, and λ_t is the market risk premium. The market risk premium is the difference between $r_t^{\text{equity, country}}$ and the risk-free rate, which is the short-term interest rate on government debt in the country. We estimate market betas in rolling five-year regressions of weekly data.[9] We approximate the cost of debt using total interest expenses in Compustat divided by total debt and assuming a tax rate of 20 percent.

2.5 Summary Statistics

The new dataset contains a diverse set of listed firms. Market value in the data ranges from 360 million USD at the 5th percentile to 54,163 at the 95th (Table 1, panel A). The data include some of the world's largest corporations, including AT&T, Bank of America, Disney,

[8]Ideally we would use expected inflation in this calculation. In the US, one can use break-even inflation as a measure of expected inflation, but such measures are not available for all countries in our sample. Using past 10-year inflation as a proxy for future inflation is common practice (e.g., the definition of Excess-CAPE by Robert Shiller). We shrink inflation towards the cross-sectional mean with a shrinkage factor of 0.5.

[9]The use of weekly data differs from the practice in asset pricing research, where betas are often estimated using monthly data over five-year horizons.[10] We use weekly data as this is more common among practitioners.

Exxon, Home Depot, Intel, JPMorgan Chase, Mastercard, Nestle, Novartis, UnitedHealth, and Visa. The total market value of firms in the data was 31.1 trillion USD in 2019, which covers 42 percent of aggregate market value in advanced economies.

The data record roughly 2,400 observations on discount rates, 2,500 on cost of capital, 4,700 on cost of debt, and 400 on cost of equity. The sample contains 2,500 unique firms with at least one of these observations in the dataset. The raw average discount rate is 16 percent, the average cost of capital 8.5, the average cost of debt 4.5, and the average cost of equity 10 (nominal values in Table 1). The perceived cost of capital is distributed fairly symmetrically, while discount rates are more dispersed (Figure 1).

We plot raw data series in Figure 2. We show the average perceived cost of debt, perceived cost of capital, and discount rates for US firms over time. The perceived cost of debt has trended downward since 2002, in line with the global decrease in interest rates, while the perceived cost of capital has also fallen, but by less. Discount rates fluctuate over time but not follow a secular trend.

Two pieces of evidence suggest that managers report meaningful numbers on the conference calls. First, a proxy for the true average cost of debt (interest expenses in Compustat) is almost identical to the average perceived cost of debt reported in different years. Second, we show in Section 4.1 that the relationship between reported discount rates and firm-level changes in investment is quantitatively very close to the predictions of a simple model.

We study whether firms in the sample are similar to other firms in Compustat. We measure the percentile rank of each firm relative to other Compustat firms in the same year and country. We then calculate the average percentile rank of firms in our sample. If the sample followed the same distribution as the Compustat population, the average rank would be close to 50. We find that firms in the sample are relatively large, as their average market value rank is 83. The unconditional probability of a Compustat firm being in our sample is roughly 3 percent, while it is roughly 50 percent for the 100 largest firms in Compustat. The selection of large firms is likely driven by the fact that conference calls of large firms are more likely to appear in Thomson One data. Firms in the sample are relatively close to the average in terms of book-to-market (average rank of 48) and investment rate (average rank of 54), while return on equity is marginally higher (average rank of 58).

3 Discount Rates, The Cost of Capital, and Wedges

In this section, we explore the relationship between the financial cost of capital, the perceived cost of capital, and discount rates. A stylized theoretical view argues that they should all be equal and move in parallel (see Section 1). We present evidence that they comove, but less than one-to-one, giving rise to time-varying wedges.

3.1 The Perceived and the Financial Cost of Capital

We first analyze the association between the perceived cost of capital and the financial cost of capital. We use two measures of the financial cost of capital, as discussed in Section 2.4: a country-level and a firm-level measure. The country-level measure is the average financial cost of capital in a country and quarter. It captures aggregate variation in capital markets and interest rates over time.

We regress a firm's perceived cost of capital on the country-level financial cost of capital in Table 2, panel A. We include country fixed effects in column 1 and firm fixed effects in column 2, so that the variation stems entirely from aggregate time-series fluctuations in capital markets and interest rates, which may be heterogeneous across countries. The stylized view of firms suggests that the point estimates should be 1. We find point estimates around 0.8, implying that when the financial cost of capital rises by 1 percentage point, the average firm increases its perceived cost of capital by 0.8 percentage points. R-squared is far from one, suggesting substantial heterogeneity in how the perceived cost of capital fluctuates across firms.

We next analyze the firm-level measure of the financial cost of capital in columns 3 and 4. This measure captures both aggregate variation and cross-sectional heterogeneity in exposure to aggregate fluctuations. We find point estimates of 0.6 and 0.5 that are, once again, statistically different from 0 and 1. The slightly lower estimates may be explained by the estimation uncertainty inherent to the firm-level financial cost of capital (Section 2.4). Despite the slightly lower slope coefficient, R-squared increases slightly, since now we also capture cross-sectional variation. Nonetheless, it is far from 1, suggesting substantial heterogeneity in perceptions across firms. We find that firms incorporate variation in the cost of equity and cost of debt to a similar degree in columns 5 and 6. Since we use delevered measures, the stylized view would again suggest that both coefficients are 1.

We explore how firms form their perceived costs of debt and equity in more detail in Table 2, panel B. We find that a long-run interest rate on government debt in the country and current interest expenses of the firm (normalized by outstanding debt) have strong predictive power, while leverage and beta do not (controlling for firm fixed effects). This suggests that the perceived cost of debt comoves with long-run country-level and current firm-level interest rates.

We also explore the perceived cost of equity in more detail. In Figure 3, we plot the perceived cost of equity along with three potential estimates for the financial cost of equity. The green line assumes a constant equity risk premium of 6 percent, which is sometimes taught to MBA students (Cochrane 2011). The two red lines use more sophisticated estimates based on the CAPE measures maintained by Robert Shiller. One of these is our baseline estimate of expected returns in the US, namely, the earnings yield plus a nominal growth rate of 4 percent (the historical average, see Section 2.4). The other estimate is the earnings yield plus a bullish expected growth rate of 6 percent. The perceived cost of equity reported by firms is most closely aligned with the estimate based on CAPE and a high growth rate.

Taken together, the data imply that firms partially incorporate changes in the financial cost of capital into their perceptions but not quite one-to-one. As a result, the cost of capital wedge υ (difference between perceived and financial cost of capital) varies over time.

As an example of this behavior, we quote a conference call of IAG (the parent company of British Airways and Iberian). IAG increased their perceived cost of equity in response to the European sovereign debt crisis in 2011, but did not lower it by as much as capital markets would have suggested after the crisis. This has implicitly raised their cost of capital wedge:

2014-11-07, IAG, Enrique Dupuy, CFO: *"We are still keeping a cost of capital of 10 percent and this is getting very conservative. We had to make a fine tuning exercise through the crisis in Spain and Europe a couple of years ago (...) and we increased the figure to this 10 percent level. But I think the assumptions are now behind (...) the 15 percent cost of equity, it appears to have a big, big premium there. Maybe those figures could be brought down slightly so 10 percent, we are keeping it there as a reference. We may be having to change it through '15 and beyond.* [edited for ease of understanding]"

3.2 Discount Rates and the Perceived Cost of Capital

We examine how discount rates move with the perceived cost of capital. We first plot pooled country-level averages of discount rates against the perceived cost of capital. There is a strong positive relationship, suggesting that countries where firms perceive the cost of capital to be high are also countries with high discount rates.

We examine within-country variation in Table 3. We initially use only observations where managers report both the discount rate and the perceived cost of capital on the same conference call. When using broad variation across firms and time in column 1, we find that firms whose perceived cost of capital is 1 percentage point higher have a discount rate that is 0.8 percentage points greater. The estimate is roughly 0.4 when including firm and firm plus year fixed effects. This implies that when a firm's perceived cost of capital changes by 1 percentage point, relative to other firms in the same year and relative to the firm's previous perceived cost, the firm adjusts its discount rate by 0.4 percentage points.

To explore the relationship for a larger set of firms, we construct a predicted value for a firm's perceived cost of capital. The predicted value is based on a lasso procedure that allows for full interactions of all components of the financial cost of capital (risk-free interest rate, beta, equity risk premium, leverage). We find similar point estimates when using the estimates of the perceived cost of capital as regressors in columns 3 to 6, although R-squared and standard errors are larger due to the estimated first stage. One advantage of this two-stage approach is that we avoid potential concerns about attenuation bias in the slope coefficient.

The stylized view posits that firms passively adopt their perceived cost of capital as discount rate, so that they should move one-to-one. We can reject a slope of 1 in all specifications using within-firm variation, suggesting that firms only partially incorporate the fluctuations in the perceived cost of capital into discount rates. The following quote from a Fortune 500 CFO illustrates this behavior:

2014-09-17, Spectra Energy, John Patrick Reddy, CFO: *"We didn't lower our hurdle rates in conjunction [with the past decrease in interest rates]. We lowered them somewhat but not just all the way down with long-term rates at 2.5 percent. We didn't take our hurdle rates down to 5 percent, for example. We are still looking at returns of, say 10 percent, on average for our projects."*

This partial incorporation implies that the discount rate wedge κ (difference between discount rate and perceived cost of capital) varies over time. We illustrate the time series behavior of κ in the US by controlling for time-invariant variation across firms. To do so, we first regress firm discount rates on year and firm fixed effects. We measure the average "within-firm" discount rate in every year by adding the year fixed effect to the unconditional mean. We follow an analogous procedure to create the average "within-firm" perceived cost of capital in every year. The difference between the two series is the "within-firm" discount rate wedge κ.

We plot the average within-firm κ in Figure 5. The wedge has increased by roughly 2.5 percentage points between 2002 and 2021. This is a large change, relative to historical movements in equity returns, interest rates, and policy rates. Much of the divergence since 2010 is driven by the fact that the perceived cost of capital has fallen while discount rates have only partially incorporated this trend and remained relatively stable. The wedge fluctuated up and down around the financial crisis, peaking in 2008.

4 Discount Rates and Investment

In this section, we analyze how discount rates and discount rate wedges relate to investment. We first study the relationship between firm-level discount rates and investment. We then highlight that time-varying discount rate wedges shed light on aggregate investment dynamics and, in particular, the recent phenomenon of "missing investment."

4.1 Firm-Level Investment and Discount Rates

We plot the average discount rate in the US, measured in the conference call data, against aggregate net investment in Figure 6. The data suggest that discount rates and investment comove.

Table 4 reports regressions of firm-level net capital investment on firm-level discount rates. All regressions include firm fixed effects, so estimates are driven by within-firm variation over time. Across a range of specifications, slope coefficients are -0.8 or -0.9. The result is stable when we control for year fixed effects in column 2, the financial cost of capital in columns 3 and 4, and Tobin's Q in columns 5 and 6. We therefore find that a firm that raises its discount rate by one percentage point more lowers its net investment rate by -0.8 percentage points more, relative to the same firm in previous years, other firms in the same year, and even when its financial cost of capital and Tobin's Q are unchanged. The stability with respect to the financial cost of capital and Tobin's Q implies that the cost of capital and discount rate wedges have an independent effect on investment. Two other measures of investment, the change in total assets in Table A.I and net investment on intangibles and capital in Table A.II, also comove with discount rates.

The results suggest that discount rates accurately measure firms' investment demand (holding constant the cash flow of its investment opportunities). In Appendix D, we study a simple Q-model of firm investment with discount rates. Under conservative assumptions about adjustment costs following Philippon (2009) and assuming a duration of Tobin's Q of 25 years, the model predicts a slope coefficient between -0.8 and -0.9, in line with our estimate.

4.2 Adjusted Q and "Missing Investment"

A recent literature argues that US investment has been low in recent decades relative to the falling financial cost of capital. The argument is usually made using Q-theory. Declines in the financial cost of capital have raised firms' equity market value and thereby led to high and rising values of Tobin's Q. According to standard Q-theory, investment should have risen with Tobin's Q. However, if anything, observed investment rates have been low relative to historical standards, leading researchers to argue that there is "missing investment" (Gutiérrez and Philippon 2017, Alexander and Eberly 2018).

We argue that the evolution of discount rate wedges can account for a large part of the decoupling between Tobin's Q and investment. Intuitively, the large and increasing discount rate wedges implies that firms are holding back investment relative to what the financial cost of capital would suggest. To make this point precise, we first introduce a model to develop an "adjusted Q," which accurately captures firms' investment incentives in the presence of time-varying wedges. We then measure adjusted Q using our new dataset and analyze its relationship to aggregate investment.

4.2.1 A Model of Adjusted Q

The firm chooses optimal investment I_t by maximizing the discounted value of future profits net of investment costs. The firm discounts cash flows using $\delta = 1 + r^{\text{fin.}} + \upsilon + \kappa$ (i.e., the sum of the financial cost of capital, a cost of capital wedge, and a discount rate wedge). The firm's problem is:

$$V_t(\upsilon + \kappa, k_t) = \max_{I_t} \quad \sum_{t=0}^{\infty} \frac{\Pi_t(k_t) - I_t - \Phi(I_t, k_t)}{(1 + r^{\text{fin.}} + \upsilon + \kappa)^t} \tag{9}$$

$$\text{s.t.} \qquad k_{t+1} = I_t + (1 - \xi) k_t \tag{10}$$

where $\Pi_t(k_t)$ is profits earned at time t using k_t units of capital, I_t is investment at time t, ξ is the depreciation rate of capital, and $V_t(\upsilon + \kappa, k_t)$ is the discounted value of the firm. The function $\Phi(I_t, k_t)$ captures adjustment costs, which are quadratic in net investment:

$$\Phi(I_t, k_t) = \frac{\phi}{2}\left(\frac{I_t}{k_t} - \xi\right)^2 k_t,$$

where $\phi \in \mathbb{R}^+$ governs the magnitude of adjustment costs. Optimal investment (see Appendix C for derivations) is:

$$\frac{I_t}{k_t} - \xi = \frac{1}{\phi}(q_t - 1), \tag{11}$$

where q_t is the Lagrange multiplier that captures the marginal value of capital:

$$q_t = \frac{\delta V_t(\upsilon + \kappa, k_t)}{\delta k_{t+1}}.$$

The marginal value of capital q_t is not observable without additional assumptions. The literature usually follows Hayashi (1982) and assumes that the production and cost functions are homogeneous of degree one. In this case, the marginal value of capital equals the average value of capital, denoted Q_t:

$$q_t = \frac{\delta V_t(\upsilon + \kappa, k_t)}{\delta k_{t+1}} = \frac{V_t(\upsilon + \kappa, k_t)}{k_{t+1}} = Q_t. \tag{12}$$

We can thus measure q_t as the value of the firm's capital relative to its replacement value. We emphasize that $V_t(\upsilon + \kappa, k_t)$ is calculated using $1 + r^{\text{fin.}} + \upsilon + \kappa$ as the discount rate. If $\upsilon + \kappa = 0$, such that the firm uses the financial cost of capital as its discount rate, we can estimate q_t on financial markets using Tobin's Q. Otherwise, however, one must correct Tobin's Q to obtain the marginal value of capital in the eyes of the firm, as summarized in the next proposition.

Proposition 1 (Adjusted Q). *If the production and investment cost functions are homogeneous of degree one, the shadow cost of capital can be approximated as:*

$$q_t \sim Q_t^{\text{Tobin}} \times \frac{1}{(\upsilon + \kappa) \times \text{Dur} + 1}, \tag{13}$$

where Dur is the duration of the firm's future cash flows. See Appendix C for the definition and proof.

If the wedges sum to zero ($\upsilon + \kappa = 0$), we can approximate marginal q using Tobin's Q. Intuitively, firms and financial markets use the same discount rate in this case and therefore agree on the value of the profits produced by capital. If the wedges are non-zero ($\upsilon + \kappa \neq 0$), we need to adjust Tobin's Q downwards because the firm uses a higher discount rate than the market, causing the firm to put a lower value on capital than the market. The strength of the adjustment naturally depends on the magnitude of the wedges, but also on the duration of the cash flows. Indeed, it is well known that the impact of the discount rate on the value of an asset depends on the duration of the asset's cash flows, which is calculated as the weighted time to maturity of the future cash flows. The longer the duration (i.e., the further into the future the average cash flow is earned), the larger the effect of discount rates on the value of the asset. For this reason, the effect of wedges increases with the duration of the firm's cash flows.

4.2.2 Empirical Analysis of Adjusted Q

We empirically implement the adjustment to Q for the average US firm. We calculate Tobin's Q using flow of funds data, following the method in Crouzet and Eberly (2022). We calculate adjusted Q by inserting the average observed discount rate wedge (κ_t) for every year in the adjustment factor.[11] We calculate the average duration over our sample based on the duration of the firms outstanding debt and equity (see Appendix C).

Figure 7 plots Tobin's Q along with our new adjusted Q. Tobin's Q is well above 1 and rises throughout the sample. Standard Q-theory would therefore predict high and rising investment throughout the sample. In contrast, adjusted Q is close to 1 and relatively stable. Adjusted Q thus corresponds more closely to the relatively low investment observed during this period.

We further explore whether the variation in discount rate wedges and adjusted Q is large enough to account for 'missing investment" by repeating the analysis of Gutiérrez and Philippon (2017). We first estimate the relationship between aggregate investment and Tobin's Q in the years 1990 to 2002. We then predict what investment since 2002 would have been if the relationship between Tobin's Q and investment had remained constant. The

[11] We set the cost of capital wedge (υ_t) equal to zero for this exercise, so that uncertainty in estimating the financial cost of capital does not affect the results.

difference between actual investment and predicted investment is "missing investment," the cumulative shortfall in investment since 2002 due to the decoupling between Tobin's Q and observed investment. The blue line in Figure 8 shows that this shortfall has reached roughly 20 percent of the capital stock.

We repeat the exercise using adjusted Q. To estimate the relationship between adjusted Q and investment in the pre-2002 sample, we need to estimate the discount rate wedge during this period. To this end, we exploit survey data from Summers (1986) and Poterba and Summers (1995) to calculate a discount rate wedge of around 3.5 percent in 1990 and linearly interpolate between this estimate and our observed wedge in 2003.[12] The red line shows that the investment shortfall relative to adjusted Q is relatively smaller and close to zero.[13] Accordingly, the investment behavior of firms is consistent with standard investment models, once we recognize that firms use discount rates that deviate from the perceived cost of capital.

Taken together, the analysis suggests that the evolution of discount rate wedges is sizable enough to account for a large part of missing investment in the 21st century. Understanding why discount rate wedges exist and why they have expanded in recent times is therefore likely to be fruitful for our understanding of seemingly low investment in recent years. We analyze this question in depth in Section 5 but, before doing so, we analyze the sensitivity of investment to the financial cost of capital more generally.

4.3 Adjusted Q and the Sensitivity of Investment to the Financial Cost of Capital

The sensitivity of investment to the financial cost of capital determines the real effects of a range of shocks (including capital market fluctuations, monetary policy, corporate taxes, etc.). We use the model of adjusted Q in Section 4.2.1 to calculate how the cost of capital and discount rate wedges affects the investment sensitivity. We approximate the effect of

[12] Poterba and Summers report an average real discount rate of 12.2 percent in 1990, which is approximately 1 percentage point lower than the real discount rate we observe in 2003. We further estimate that the real financial cost of capital went down by approximately 2 percentage points between 1990 and 2003. Taken together, these estimates suggest that the wedge in 1990 was 3 percentage points lower than in 2003 (where we observe a wedge of 6.5). Summers (1986) documents an average real discount rate of 10 percent in 1986, consistent with low discount rate wedges around 1990.

[13] In Table table:missing$_{i}nv, weshowtheunderlyingregressions.Thereisnostatisticallysignificantinvestmentshortfallaft$

the cost of capital on net investment (following Proposition 2) as:

$$\frac{\Delta\left(\frac{I_t}{k_t}-\delta\right)}{\Delta r^{\text{fin.}}} = \frac{\Delta\left(\frac{I_t}{k_t}-\delta\right)}{\Delta(r^{\text{fin.}}+\upsilon+\kappa)}\frac{\Delta(r^{\text{fin.}}+\upsilon+\kappa)}{\Delta r^{\text{fin.}}} \tag{14}$$

$$\sim\left(1+\frac{\Delta(\upsilon+\kappa)}{\Delta r^{\text{fin.}}}\right)\times\frac{1}{\phi}\times\frac{\text{Dur}}{(\upsilon+\kappa)\times\text{Dur}+1}. \tag{15}$$

Two channels dampen the investment sensitivity when wedges are positive: the wedge channel and the duration channel. The wedge channel is related to the ratio $\frac{\Delta(r^{\text{fin.}}+\upsilon+\kappa)}{\Delta r^{\text{fin.}}}$. This ratio is generally smaller than one in the data and therefore reduces the investment sensitivity. To isolate the duration channel, imagine that firms incorporate changes in the financial cost of capital one-to-one into discount rates $\left(\text{i.e., } \frac{\Delta(r^{\text{fin.}}+\upsilon+\kappa)}{\Delta r^{\text{fin.}}}=1\right)$. In this case, positive wedges ($\upsilon+\kappa>0$) reduce the duration of cash flows. In turn, this lowers the sensitivity of investment to discount rate movements.

Figure A.III shows the sensitivity of the financial cost of capital on investment rates under different assumptions. Here, we measure the sensitivity as the semi-elasticity, in line with much of the literature, which is defined as the percentage change in gross investment relative to a 1 percentage point change in the financial cost of capital.[14] In a model with zero wedges, the semi-elasticity is 0.25. It falls to 0.12 when we incorporate the average observed discount rate wedge of 8 percentage points in the data. It further drops to 0.05 if we also add the duration channel. These numbers suggest that discount rate wedges can have first-order impact on the investment sensitivity.

5 Drivers of Discount Rates and Wedges

We have so far established that there exist time-varying wedges between the cost of capital and discount rates that are large enough to have quantitatively important implications for investment dynamics. In this section, we investigate how firms pick discount rates and why the wedges vary over time. We first outline theories that explain the origins of wedges and then test them in the data.

[14] We assume a cash flow duration of 25 years (see Appendix C) and that $\phi=10$, following Philippon (2009).

5.1 Theoretical Explanations for Wedges

5.1.1 Market Power

In perfectly competitive markets, all firms must earn the same return after accounting for risk and potential frictions. If the financial cost of capital changes and one firm lowers its required rate of return and therefore its discount rate, all other firms in its market have to follow suit. Otherwise, the other firms will not be able to find positive NPV projects. Market pressures thus discipline firms to keep wedges low.

This theory predicts that firms with less market power use discount rate wedges closer to zero once accounting for risk and frictions. More importantly, the theory predicts that firms in competitive markets incorporate new changes in the cost of capital more strongly. In contrast, firms with high market power do not necessarily incorporate new changes in their cost of capital into discount rates, meaning discount rate wedges are likely to increase when the cost of capital decreases.

5.1.2 Risk and Uncertainty

A firm's financial cost of capital should generally capture the compensation for risk required by investors. However, there are a number of reasons why firms might incorporate risk into their discount rates over and above the financial cost of capital. First, if a firm's new project is riskier than its current projects, the firm should raise the discount rate for the project. If new projects are generally riskier than existing ones (because there is more uncertainty), the average firm has positive wedges.

Second, real option theory shows that when investment projects are risky and (fully or partially) irreversible, the optimal investment decision depends on the uncertainty of the cash flows (Ingersoll Jr. and Ross 1992, Dixit and Pindyck 1994, Abel and Eberly 1996). The more uncertainty, the longer the firm should postpone investing. While, in theory, the optimal investment decision uses the financial cost of capital as discount rate, McDonald (2000) argues that a firm can approximate optimal behavior by increasing its wedge in the face of uncertainty. Real options theory therefore implies that firms with more uncertain projects have higher wedges in the cross section. It also predicts that increases in uncertainty raise wedges most strongly for firms with more irreversible projects.

Third, risk may lead to higher discount rate wedges because managers may be more exposed to the idiosyncratic performance of the firm than investors, for example due to firm-specific human capital or their compensation structure. If a manager aims at maximizing personal utility, it might therefore be optimal to raise discount rates in the face of risk. Finally, if equity is mispriced, managers may want to adjust discount rates by incorporating the correct risk factors (Stein 1996).

The 2021 Association of Finance Professionals Survey finds that close to half of respondents increase discount rates in the face of increased uncertainty. The following quote gives an example of such behavior:

2016-11-10, Halyard Health Inc., Steve Voskuil, CFO: *"...So that's kind of how we come to the 9 percent [hurdle rate]. We start with the capital markets' rates and look at our capital structure, and then we add a little bit to that to reflect risk in the portfolio and execution."*

5.1.3 Financial and Organizational Constraints

Firms may face constraints that are not normally included in NPV analyses. Firms can implicitly incorporate these constraints in their investment decision by including the shadow price of the constraint in their discount rate. For instance, Jagannathan and Meier (2002) argue that firms facing organizational constraints should include the shadow cost of managerial attention in their discount rates. Similarly, firms facing financial frictions might want to include the shadow cost of capital over and above their financial cost of capital.

This theory predicts that firms with more constraints are more likely to have higher discount rates and wedges. The following quote illustrates how financial constraints can affect discount rates:

2016-10-19, Kinder Morgan, Kim Dang, CFO: *"We are living within our cash flow, meaning that we want to be able to fund our CapEx and our dividend from our cash flow. And so that is the constraint, and so, because we have a limited amount of capital, that is why we have the hurdle rate set at 15 percent IRR for projects."*

5.1.4 Cash Flow Inflation and Behavioral Biases

Managers may worry that internal cash flow forecasts are excessively optimistic. By using higher discount rates, they can correct for such inflation. However, investors and analysts generally expect firms to earn their discount rate on their marginal project, so such behavior may apply more frequently to small firms that do not periodically hold conference calls with investors. (Large firms that frequently face interactions with investors can easily avoid this problem by adjusting expected growth rates instead of discount rates.) This theory suggests that wedges may be non-zero on average but does not predict that wedges should vary over time.

Managers may also face uncomfortable questions when a project earns less than the financial cost of capital. As insurance, they may introduce wedges. The following quote from the Fortune 500 company Kinder Morgan is a real-life illustration for such behavior:

2013-05-23, Kinder Morgan, Kim Dang, CFO: *"We do not do projects close to our cost of capital (...) – our cost of capital is 9 percent, we are not going to go out and do a project in 9.5 percent or 10 percent because there are just too many potential for changes in what you expect to happen (...) We're not going to take the risk that we have a project come in at or below our cost of capital."*

This theory relies on managerial biases. The effect of this an other behavioral biases on discount rate wedges interacts with market power. Firms with high market power may be more likely to make such mistakes without being forced to improve their operations and reduce wedges. As a result, a testable implication of such biases is again that firms with high market power have higher wedges.

5.2 The Drivers of Cross-Sectional Variation in Discount Rates and Wedges

The theories above predicted that, in the cross section, firms with higher market power, risk, and financial constraints have greater discount rates and greater wedges. We measure firm-level market power using the accounting method in Baqaee and Farhi (2020), volatility using one-year option implied equity volatility, and financial constraints using the index by Hadlock and Pierce (2010).[15] Since we are initially interested in cross-sectional variation, we average these variables for the period 2000 to 2002 and include country and year fixed effects in the regressions. Variables are standardized, so that coefficients estimate the impact of a one standard deviation increase.

In Table 5, we find that firms with greater market power have higher discount rates (column 1), higher discount rate wedges (column 2), and higher total wedges (discount rate

[15]We find similar results using the measure of market power by De Loecker et al. (2020).

wedge plus cost of capital wedge, column 3). The coefficients are statistically significant and economically large. Similarly, riskier firms also have statistically and economically higher discount rates and wedges. The coefficients on financial constraints are all positive and economically significant, but only association with the total wedge is statistically significant. Together, the variables explain 18 percent of total variation in discount rates.

5.3 The Drivers of Time Variation in Discount Rates and Wedges

We next study time variation in discount rate wedges. The main goal of this analysis is to understand the secular upward trend in the average discount rate wedge (Figure 5) and thus the drivers behind the missing investment puzzle. However, the analysis also speaks to time variation in discount rate wedges at the firm level and at shorter time horizons.

Many of the theories laid out in Section 5.1 apply to cross-sectional variation and do not speak directly to time variation in discount rates and wedges. Below, we consider two of the most promising theories for time variation, namely, theories revolving around risk and theories revolving around market power.

5.3.1 Market Power and the Increase in Discount Rate Wedges

As explained in 5.1.1, firms with high market power are less likely to adjust discount rates when the financial cost of capital falls as they face less competitive pressure to do so. Consistent with this argument, we find evidence that firms with high market power have kept their discount rates high in recent decades while firms with low market power have decreased their discount rates as the cost of capital has gone down.

We first illustrate this finding based on a simple sample split. We split the sample into two groups based on firms' average market power between 2000 and 2002. We continue to measure market power using accounting profits, as in Baqaee and Farhi (2020), but the results are robust to using the measure in De Loecker et al. (2020). Based on this sample split, we calculate calculate the average discount rate in each year separately for each group. We do so in firm-year panel regressions that include firm fixed effects, such that the results are driven by within-firm variation in discount rates (as in Section 3.2).

Figure 9 plots the resulting time series of discount rates for the high- and low-market power groups. Discount rates of firms with high market power are relatively stable over the period and, if anything, increase slightly, even though the financial cost of capital has trended downward over this period. In contrast, discount rates of firms with low market power have fallen. These patterns are consistent with the view that competitive pressures force firms to adjust discount rates with decreases in the financial cost of capital.

We test these dynamics formally in Table 6. We regress firm-level discount rates and wedges on a series of interaction terms. We include firm fixed effects so results are again driven by within-firm variation in discount rates and wedges over time. We first interact market power with a time trend. The results show that firms with higher market power in 2002 increased their discount rate (column 1) and their wedges (columns 4 and 7) by significantly more between 2002 and 2021. The point estimate implies that a standard deviation increase in market power is associated with a 2.5 percentage point increase in the discount rate wedge over the sample.

We next interact market power with the country-level perceived cost of capital, finding that firms with higher market power also reacted significantly more to changes in the financial cost of capital (columns 2, 5, and 8). The magnitude is such that a firms with a one standard deviation higher market power incorporate a percentage point shock to the cost of capital by 0.43 percentage points less. The interaction of market power with the firm-level financial cost of capital also supports this conclusion, although estimates are less precise (columns 3, 6, and 9). Taken together, these results are consistent with the view that market power has limited the extent to which the secular decline in the financial cost of capital has been incorporated into discount rates.

5.3.2 Time-Varying Risk and Discount Rate Wedges

Section 5.1.2 explains how theories based on real options offer one potential mechanism through which risk might influence discount rate wedges. According to real options theory, time variation in risk should influence wedges more strongly for firms with more irreversible projects. To test this prediction, we interact a firm's option-implied volatility in a given year with a time-invariant measure of asset irreversibility at the industry level (Kim and Kung 2017).[16] We also include firm fixed effects. In Table 7, we report that changes in volatility affect firms with high irreversibility more strongly. The interaction effect is statistically significant for the discount rate wedge (column 2) and the total wedge (column 3). These results are consistent with the notion that time variation in risk leads to time variation in wedges through the real option channel.

By our baseline metric, the implied volatility of equity, we do not see a secular increase in risk over our sample, meaning that uncertainty by this measure does not explain the secular

[16] We measure asset irreversibility as the average between 2000 and 2002.

increase in the average wedge. However, we note that to the extent that economic policy uncertainty has increased in recent decades (Baker et al. 2016), an increase in uncertainty may have played a role for understanding the trend in the wedge.[17]

6 Conclusion

This paper presents a new dataset on firms' discount rates and perceived cost of capital, augmented with measures of the financial cost of capital and investment. We find that firms partially incorporate changes in the financial cost of capital into their perceived cost of capital. In addition, discount rates move with the perceived cost of capital, but significantly less than one-to-one. These patterns leads to large and time-varying wedges between discount rates and the financial cost of capital. Moreover, we find that discount rates are strongly negatively related to investment.

Discount rate wedges have trended upward substantially in recent decades. The average firm in our sample has increased its discount rate wedge by 2.5 percentage points between 2002 and 2021. This pattern affects our understanding of aggregate investment dynamics. The large and growing wedge suggests that firms have invested less relative to what we would expect given the financial cost of capital. The magnitude of this effect is large. Using a new adjusted Q-model, we show that the increase in the average wedge is large enough to account for the low levels of aggregate investment (relative to valuations in financial markets) observed in recent decades.

In exploring the drivers of discount rate wedges, we find important roles for both market power and risk. Riskier firms add higher wedges to their cost of capital, consistent with theories based on real options. Firms with high market power also add higher wedges. In addition, we find that the upward trend in discount rate wedges has been driven by firms with high market power. While firms with high market power have increased their wedges over the sample, firms with low market power have decreased their discount rates almost one-to-one with the change in the financial cost of capital, implying that their wedges have been relatively constant over time. These results suggest that market power has limited the extent to which the secular decline in the financial cost of capital has been incorporated into discount rates.

[17] This finding is distinct from the increasing risk premia studied by Farhi and Gourio (2018). Risk premia influence discount rates through the impact on the financial cost of capital whereas the impact of uncertainty on wedges generates a distinct, and potentially larger, impact on discount rates.

References

Abel, A. B. and J. C. Eberly (1996): "Optimal Investment With Costly Reversibility," *Review of Economic Studies*, 63, 581–593.

Alexander, L. and J. C. Eberly (2018): "Investment Hollowing Out," *IMF Economic Review*, 66, 5–30.

Baker, S. R., N. Bloom, and S. J. Davis (2016): "Measuring Economic Policy Uncertainty," *Quarterly Journal of Economics*, 131, 1593–1636.

Baqaee, D. R. and E. Farhi (2020): "Productivity and misallocation in general equilibrium," *The Quarterly Journal of Economics*, 135, 105–163.

Barro, R. J. (1990): "The Stock Market and Investment," *Review of Financial Studies*, 3, 115–131.

Bond, P., A. Edmans, and I. Goldstein (2012): "The Real Effects of Financial Markets," *Annual Review of Financial Economics*, 4, 339–360.

Campbell, J. Y. and S. B. Thompson (2008): "Predicting Excess Stock Returns Out of Sample: Can Anything Beat the Historical Average?" *Review of Financial Studies*, 21, 1509–1531.

Cieslak, A. and A. Vissing-Jørgensen (2021): "The Economics of the Fed Put," *Review of Financial Studies*, 34, 4045–4089.

Cochrane, J. H. (1991): "Production-Based Asset Pricing and the Link Between Stock Returns and Economic Fluctuations," *Journal of Finance*, 46, 209–237.

——— (2011): "Presidential Address: Discount Rates," *Journal of Finance*, 66, 1047–1108.

Crouzet, N. and J. C. Eberly (2022): "Rents and Intangible Capital: A Q+ Framework," *Journal of Finance – forthcoming.*

De Loecker, J., J. Eeckhout, and G. Unger (2020): "The Rise of Market Power and the Macroeconomic Implications," *Quarterly Journal of Economics*, 135, 561–644.

Décaire, P. H. (2021): "Capital Budgeting and Idiosyncratic Risk," .

Dessaint, O., J. Olivier, C. A. Otto, and D. Thesmar (2021): "CAPM-Based Company (Mis)valuations," *Review of Financial Studies*, 34, 1–66.

Dixit, R. K. and R. S. Pindyck (1994): *Investment Under Uncertainty*, Princeton University Press.

Fama, E. F. and K. R. French (1992): "The Cross-Section of Expected Stock Returns," *Journal of Finance*, 47, 427–465.

——— (1997): "Industry Costs of Equity," *Journal of Financial Economics*, 43, 153–193.

Farhi, E. and F. Gourio (2018): "Accounting for Macro-Finance Trends: Market Power, Intangibles, and Risk Premia," *Brookings Papers on Economic Activity*, Fall, 147–223.

Frankel, R., M. Johnson, and D. J. Skinner (1999): "An Empirical Examination of Conference Calls as a Voluntary Disclosure Medium," *Journal of Accounting Research*, 37, 133–150.

Frazzini, A. and L. H. Pedersen (2014): "Betting Against Beta," *Journal of Financial Economics*, 111, 1–25.

Gilchrist, S. and E. Zakrajšek (2012): "Credit Spreads and Business Cycle Fluctuations," *American Economic Review*, 102, 1692–1720.

Gomes, J. F., L. Kogan, and L. Zhang (2003): "Equilibrium Cross Section of Returns," *Journal of Political Economy*, 111, 693–732.

Gormsen, N. J. and K. Huber (2022): "Equity Factors and Firms' Perceived Cost of Capital," .

Gormsen, N. J. and E. Lazarus (2022): "Duration-Driven Returns," *Journal of Finance – forthcoming.*

Graham, J. R. (2022): "Presidential Address: Corporate Finance and Reality," .

Graham, J. R. and C. R. Harvey (2001): "The Theory and Practice of Corporate Finance: Evidence from the Field," *Journal of Financial Economics*, 60, 187–243.

Greenwood, R. and A. Shleifer (2014): "Expectations of Returns and Expected Returns," *Review of Financial Studies*, 27, 714–746.

Gutiérrez, G. and T. Philippon (2017): "Investment-Less Growth: An Empirical Investigation," NBER Working Paper 22897.

Hadlock, C. J. and J. R. Pierce (2010): "New evidence on measuring financial constraints: Moving beyond the KZ index," *The review of financial studies*, 23, 1909–1940.

Hall, R. E. (2017): "High Discounts and High Unemployment," *American Economic Review*, 107, 305–30.

Hassan, T. A., S. Hollander, L. Van Lent, and A. Tahoun (2019): "Firm-Level Political Risk: Measurement and Effects," *Quarterly Journal of Economics*, 134, 2135–2202.

Hayashi, F. (1982): "Tobin's Marginal Q and Average Q: A Neoclassical Interpretation," *Econometrica*, 213–224.

Hennessy, C. A., A. Levy, and T. M. Whited (2007): "Testing Q Theory With Financing Frictions," *Journal of Financial Economics*, 83, 691–717.

Hou, K., C. Xue, and L. Zhang (2015): "Digesting Anomalies: An Investment Approach," *Review of Financial Studies*, 28, 650–705.

Ingersoll Jr., J. E. and S. A. Ross (1992): "Waiting to Invest: Investment and Uncertainty," *Journal of Business*, 1–29.

Jagannathan, R., J. Liberti, B. Liu, and I. Meier (2017): "A Firm's Cost of Capital," *Annual Review of Financial Economics*, 9, 259–282.

Jagannathan, R., D. A. Matsa, I. Meier, and V. Tarhan (2016): "Why Do Firms Use High Discount Rates?" *Journal of Financial Economics*, 120, 445–463.

Jagannathan, R. and I. Meier (2002): "Do We Need CAPM for Capital Budgeting?" .

Jorgenson, D. (1963): "Capital Theory and Investment Behavior," *American Economic Review*, 53, 247–259.

Kim, H. and H. Kung (2017): "The asset redeployability channel: How uncertainty affects corporate investment," *The Review of Financial Studies*, 30, 245–280.

Krüger, P., A. Landier, and D. Thesmar (2015): "The WACC Fallacy: The Real Effects of Using a Unique Discount Rate," *Journal of Finance*, 70, 1253–1285.

McDonald, R. L. (2000): "Real Options and Rules of Thumb in Capital Budgeting," in *Project Flexibility, Agency, and Competition*, ed. by M. J. Brennan and L. Trigeorgis, Oxford University, 13–33.

Pástor, Ľuboš. and R. F. Stambaugh (1999): "Costs of Equity Capital and Model Mispricing," *Journal of Finance*, 54, 67–121.

Pflueger, C., E. Siriwardane, and A. Sunderam (2020): "Financial Market Risk Perceptions and the Macroeconomy," *Quarterly Journal of Economics*, 135, 1443–1491.

Philippon, T. (2009): "The Bond Market's Q," *Quarterly Journal of Economics*, 124, 1011–1056.

Poterba, J. M. and L. H. Summers (1995): "A CEO Survey of US Companies' Time Horizons and Hurdle Rates," *MIT Sloan Management Review*, 37, 43.

Sharpe, S. A. and G. A. Suarez (2021): "Why Isn't Business Investment More Sensitive to Interest Rates? Evidence from Surveys," *Management Science*, 67, 720–741.

Stein, J. C. (1996): "Rational Capital Budgeting in an Irrational World," *Journal of Business*, 69, 429–455.

Summers, L. H. (1986): "Investment Incentives and the Discounting of Depreciation Allowances," NBER Working Paper 1941.

Tobin, J. (1969): "A General Equilibrium Approach to Monetary Theory," *Journal of Money, Credit and Banking*, 1, 15–29.

Trahan, E. A. and L. J. Gitman (1995): "Bridging the Theory-Practice Gap in Corporate Finance: A Survey of Chief Financial Officers," *Quarterly Review of Economics and Finance*, 35, 73–87.

van Binsbergen, J. H. (2020): "Duration-Based Stock Valuation: Reassessing Stock Market Performance and Volatility," NBER Working Paper 27367.

van Binsbergen, J. H. and C. C. Opp (2019): "Real Anomalies," *Journal of Finance*, 74, 1659–1706.

Vasicek, O. (1977): "An Equilibrium Characterization of the Term Structure," *Journal of Financial Economics*, 5, 177–188.

Welch, I. and A. Goyal (2008): "A Comprehensive Look at the Empirical Performance of Equity Premium Prediction," *Review of Financial Studies*, 21, 1455–1508.

Zhang, L. (2005): "The Value Premium," *Journal of Finance*, 60, 67–103.

Zwick, E. and J. Mahon (2017): "Tax Policy and Heterogeneous Investment Behavior," *American Economic Review*, 107, 217–48.

Table 1
Summary Statistics on Corporate Discount Rates from Conference Calls

This table reports summary statistics of metrics extracted from the earnings conference calls. Panel A reports summary statistics of variables from the conference calls as well as characteristics of included firms. Panel B reports a broader set of characteristics of included firms, where characteristics are measured in cross-sectional percent of the universe of firms (controlling for year and country of listing).

	(1)	(2)	(3)	(4)
VARIABLES	N	Mean	P5	P95
Panel A: Summary statistics				
Perceived cost of debt	4,668	0.045	0.016	0.083
Perceived cost of equity	373	0.10	0.053	0.15
Perceived cost of capital	2,548	0.085	0.041	0.12
Discount rate	2,398	0.16	0.080	0.29
Market value (million USD)	6,612	13,521	360	54,163
Return on equity	5,780	0.10	-0.063	0.28
Panel B: Characteristics of included firms (percentile of all Compustat firms)				
Market value (percentile)	6,612	82.5	45.0	99.3
Book-to-market (percentile)	5,480	47.7	5.63	91.1
Return on equity (percentile)	6,360	58.4	17.6	91.3
Physical capital (percentile)	6,177	61.6	8.66	96.9
Investment rate (percentile)	5,636	53.5	10.6	87.5

Table 2
The Perceived and the Financial Cost of Capital

This table reports results of panel regressions of the firm-quarter level perceived cost of capital on measures of the financial cost of capital at the firm and country level (see Section 2.4 for definitions). Standard errors are double-clustered by year and country. The sample is 2002 to 2021. The left- and right-hand side variables are measured in percentage points.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A			Perceived Cost of Capital			
Financial WACC (country-level)	0.88***	0.67***				
	(0.14)	(0.19)				
Financial WACC (firm-level)			0.64***	0.49***		
			(0.11)	(0.13)		
Delevered Cost of Equity (firm)					0.72***	0.47***
					(0.12)	(0.16)
Deleverd Cost of Debt (firm)					0.51***	0.54***
					(0.14)	(0.16)
Constant	4.28***	5.24***	4.88***	5.65***	4.69***	5.70***
	(0.63)	(0.90)	(0.59)	(0.71)	(0.59)	(0.76)
Observations	1,968	1,448	2,058	1,520	2,058	1,520
R-squared	0.097	0.803	0.128	0.801	0.131	0.801
FE	Country	Firm	Country	Firm	Country	Firm
Within R2	0.047	0.070	0.088	0.092	0.091	0.093

Panel B			Perceived Cost of Debt			
Long-Term Rates (country-level)	0.34***	0.26***	0.044	0.34***	0.27***	0.047
	(0.062)	(0.064)	(0.068)	(0.061)	(0.063)	(0.066)
Interest expense (firm-level)	0.32***	0.25***	0.18***	0.31***	0.25***	0.18***
	(0.051)	(0.039)	(0.038)	(0.049)	(0.039)	(0.038)
Leverage ratio				0.87***	-0.13	-0.036
				(0.21)	(0.39)	(0.33)
Beta				0.34	0.16	0.19
				(0.23)	(0.34)	(0.33)
Constant	2.03***	2.50***	3.28***	1.46***	2.38***	3.10***
	(0.22)	(0.24)	(0.28)	(0.30)	(0.42)	(0.37)
Observations	3,114	2,735	2,735	3,114	2,735	2,735
R-squared	0.550	0.834	0.857	0.564	0.834	0.857
FE	Country	Firm	Firm/year	Country	Firm	Firm/year
Within R2	0.41	0.32	0.087	0.43	0.32	0.088

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

Table 3
Discount Rates and the Perceived Cost of Capital

This table reports results of panel regressions of the firm-quarter level discount rates on the perceived cost of capital,

$$\text{Discount rate}_t^i = \beta_0 + \beta_1 \text{Perc. cost of capital}_t^i + \upsilon_t^i$$

where i denotes firm and t denotes time. The three left-most columns use the perceived cost of capital measured in conference calls on the right-hand side. The three rightmost columns use the predicted perceived cost of capital based on the financial cost of capital. The predicted perceived cost of capital is calculated based on a lasso regression as explained in the text. The sample runs from 2002 to 2021. Standard errors are double-clustered by firm and year. The left- and right-hand side variables are measured in percentage points.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES			Discount Rate			
Perceived WACC (firm-level)	0.79***	0.44***	0.38***			
	(0.076)	(0.12)	(0.12)			
Predicted perc. WACC (Lasso)				1.10**	0.44	0.40*
				(0.42)	(0.26)	(0.23)
Constant	4.61***	7.75***	8.20***	6.42*	12.3***	12.6***
	(0.81)	(1.01)	(1.01)	(3.60)	(2.21)	(1.93)
Observations	217	132	127	1,873	1,388	1,388
R-squared	0.324	0.982	0.984	0.104	0.965	0.967
FE	Country	Firm	Firm/year	Country	Firm	Firm/year
P(slope = 1)	0.014	0.00012	0.00010	0.81	0.044	0.016
Within R2	0.24	0.41	0.27	0.023	0.025	0.012

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

Table 4
Investment and Discount Rates

This table reports results of panel regressions of the firm-level investment rate on discount rates. We consider net investment measured as $I_t = (\text{CAPEX}^i_{t+1} - \text{Depreciation}^i_{t+1})/\text{PPEN}^i_t$. Right hand side variables are all measured at time t, as detailed in the text. Tobin's Q is measured as the book-to-market value of debt and equity. Standard errors are double-clustered by firm and date. The left- and right-hand side variables are measured in percentage points. Sample is 2002 to 2021 and excludes firms in the financial sector. Fin. cost of capital is the financial cost of capital estimated using the WACC and the CAPM.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Dependent variable: Net Investment					
Discount rate	-0.90***	-0.84***	-0.90***	-0.86***	-0.82**	-0.75**
	(0.27)	(0.25)	(0.29)	(0.27)	(0.36)	(0.35)
Financial WACC (firm-level)			0.69	0.78	1.42	1.20
			(0.75)	(0.91)	(0.98)	(1.16)
Tobin's Q					1.13**	1.01*
					(0.44)	(0.51)
Observations	1,004	1,004	957	957	794	794
R-squared	0.791	0.811	0.801	0.820	0.810	0.833
FE	Firm	Firm/year	Firm	Firm/year	Firm	Firm/year
Cluster	Firm/year	Firm/year	Firm/year	Firm/year	Firm/year	Firm/year
Within R^2	0.039	0.034	0.043	0.041	0.062	0.050

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

Table 5
Differences in Discount Rates and Wedges Across Firms

This table reports results of panel regressions of the firm-level discount rates and discount rate wedges on three different metrics that may explain discount rate wedges. The first is market power, measured using the accounting method in Baqaee and Farhi (2020). The second is volatility, measured using the firms' implied volatility. The third is financial constraints, measured using the index by Hadlock and Pierce (2010). The right-hand side variables are average values between 2000 and 2002. Sample is 2002 to 2021. All right-hand side variables are standardized.

	(1)	(2)	(3)
VARIABLES	Discount rate	κ	$\kappa + \upsilon$
Market Power (2002)	1.30*	1.18*	1.23*
	(0.63)	(0.60)	(0.60)
Risk (2002)	2.14***	1.72***	1.47***
	(0.57)	(0.53)	(0.50)
Fin. Constraints (2002)	0.83	0.97	1.05*
	(0.56)	(0.57)	(0.55)
Observations	799	799	799
R-squared	0.184	0.169	0.163
FE	Country/year	Country/year	Country/year
Cluster	Firm/year	Firm/year	Firm/year
Within R^2	0.12	0.10	0.095

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

Table 6
The Role of Market Power in the Evolution of Discount Rates and Wedges

This table reports results of panel regressions of the firm-level discount rates and discount rate wedges on market power in 2002 interacted with three different variables: calendar year, perceived cost of capital at the country level, and the (predicted) the perceived cost of capital at the firm level. Market power standardized and measured using the accounting method in Baqaee and Farhi (2020). Sample is 2002 to 2021. The table only shows the slope coefficients for the interaction terms. The discount rate wedge κ_t is measured as the discount rate minus the (predicted) perceived cost of capital. Standard errors are clustered by firm and year.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	Discount rate (δ)			Discount rate wedge (κ)			Both wedges ($\kappa + \upsilon$)		
Market Power (2002)*Year	0.13**			0.12**			0.13**		
	(0.061)			(0.054)			(0.055)		
Market Power (2002)*Country perc. WACC		-0.43**			-0.38**			-0.40**	
		(0.19)			(0.18)			(0.19)	
Market Power (2002)*Predicted perc. WACC			-0.30			-0.30			-0.24
			(0.21)			(0.21)			(0.24)
Observations	723	720	723	723	720	723	723	720	723
R-squared	0.963	0.960	0.963	0.959	0.958	0.961	0.943	0.941	0.951
FE	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm
Within R^2	0.11	0.044	0.035	0.056	0.023	0.035	0.049	0.021	0.041

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

Table 7
The Role of Risk in the Evolution of Discount Rates and Wedges

This table reports results of panel regressions of the firm-level discount rates and discount rate wedges on firm-level implied volatility interacted with the irreversibility of assets in 2002. We measure irreversibitlity as the negative of asset deployability from Kim and Kung (2017). Sample is 2002 to 2021. All right-hand side variables are standardized.

VARIABLES	(1) Discount rate	(2) κ	(3) $\kappa + \upsilon$
Risk	1.27	0.027	-0.90
	(1.88)	(1.86)	(1.59)
Risk*Irreversibility	3.99	8.29*	12.1**
	(3.79)	(4.09)	(4.86)
Observations	581	581	581
R-squared	0.957	0.953	0.941
FE	Firm	Firm	Firm
Cluster	Firm/year	Firm/year	Firm/year
Within R^2	0.0013	0.025	0.055

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

Figure 1
Histograms of the Perceived Cost of Capital and Discount Rates

This figure plots histograms for the perceived cost of capital and discount rates.

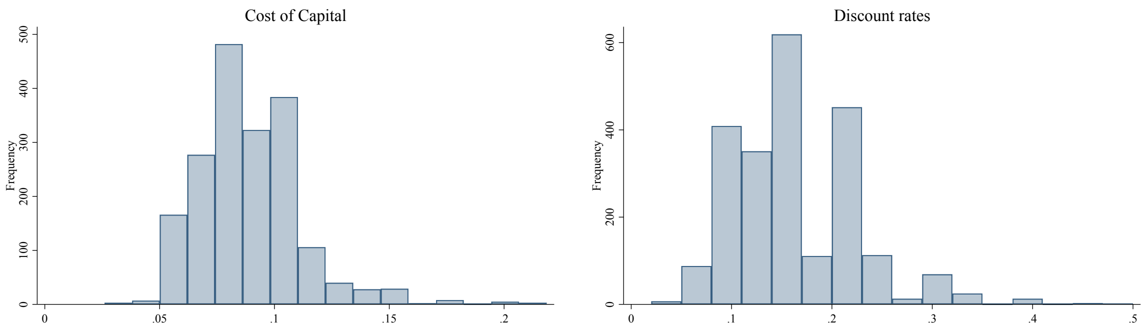


Figure 2
The Time Series of Corporate Discount Rates

This figure plots the average discount rate, perceived cost of capital, and perceived cost of debt for different years in the US.

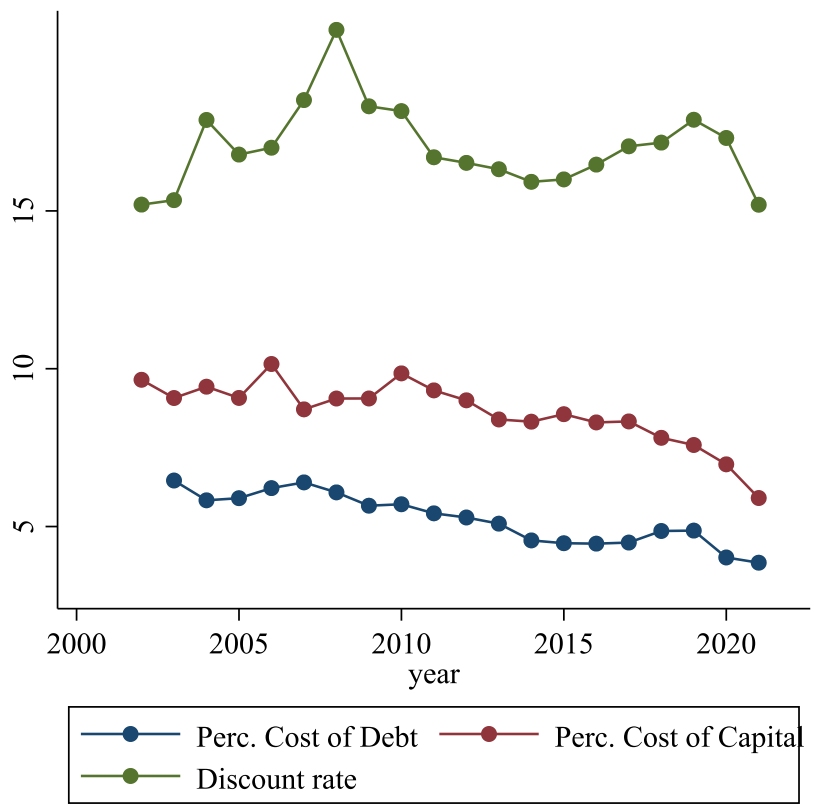


Figure 3
The Perceived Cost of Equity

This figure plots the perceived cost of equity along with three different estimates of expected stock returns. We estimate the average average perceived cost of equity in each year in a firm-year panel that includes firm fixed effects. The figure plots three-year moving averages. We include two measures based on the earnings yield, one which assumes a real growth of 2 percent and one which assumes a real growth of 4 percent. The "standard MBA class" measure is calculated as the risk-free rate plus the long-run market risk premium of 6 percent, as in the example by Cochrane (2011). Panel A plots expected stock returns/cost of equity and Panel B plots expected stock returns/cost of equity measured in excess of the risk-free interest rate.

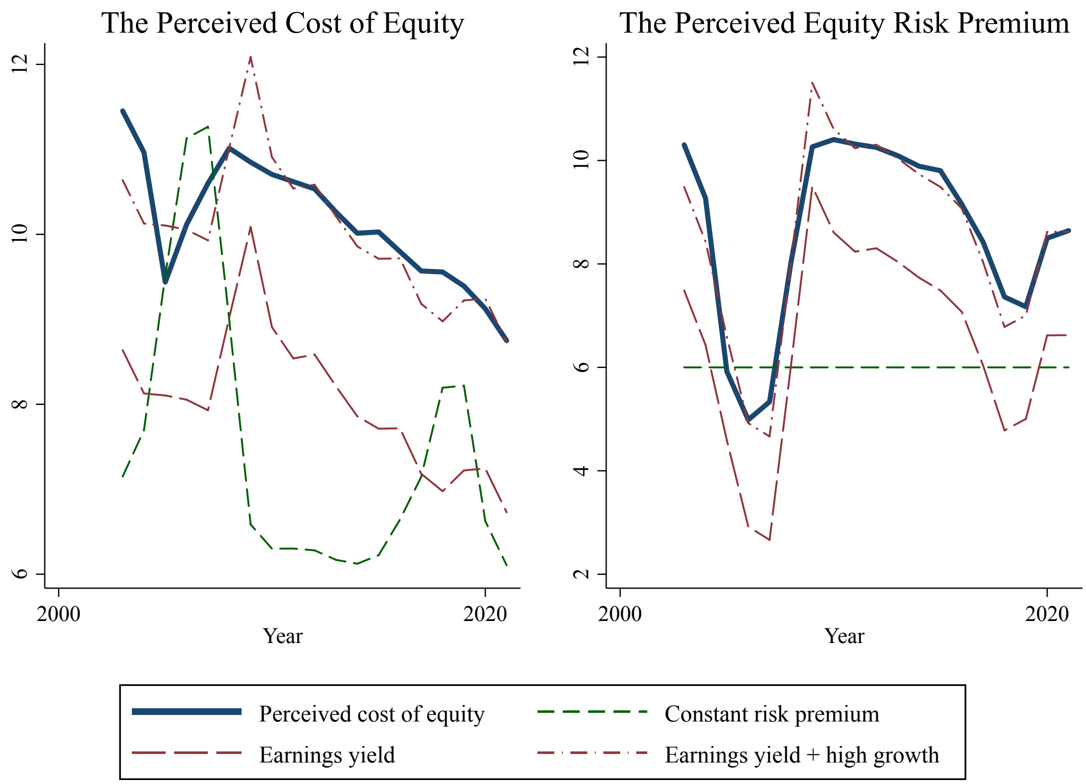


Figure 4
Discount Rates and Cost of Capital in Different Countries

This figure plots the average discount rates and perceived cost of capital in the different countries in our sample. Data are from 2002 to 2021.

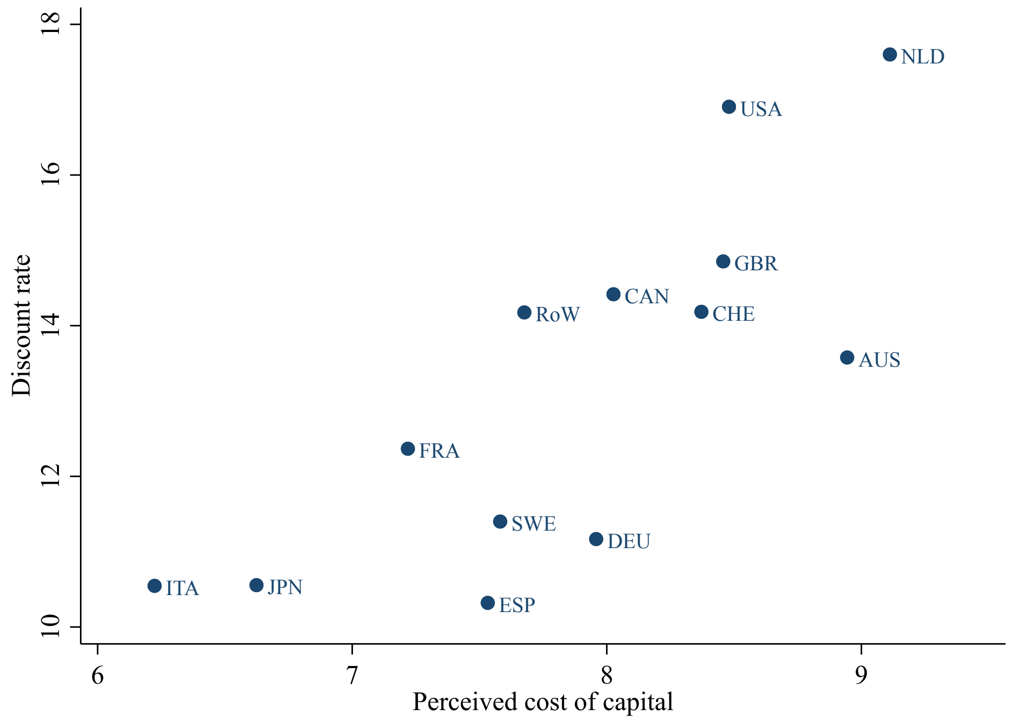


Figure 5
The Discount Rate Wedge

This figure plots the discount rate wedge in the US sample. We estimate the average discount rate and cost of capital for each year using firm fixed effects. The wedge is the ratio of the discount rate to the cost of capital.

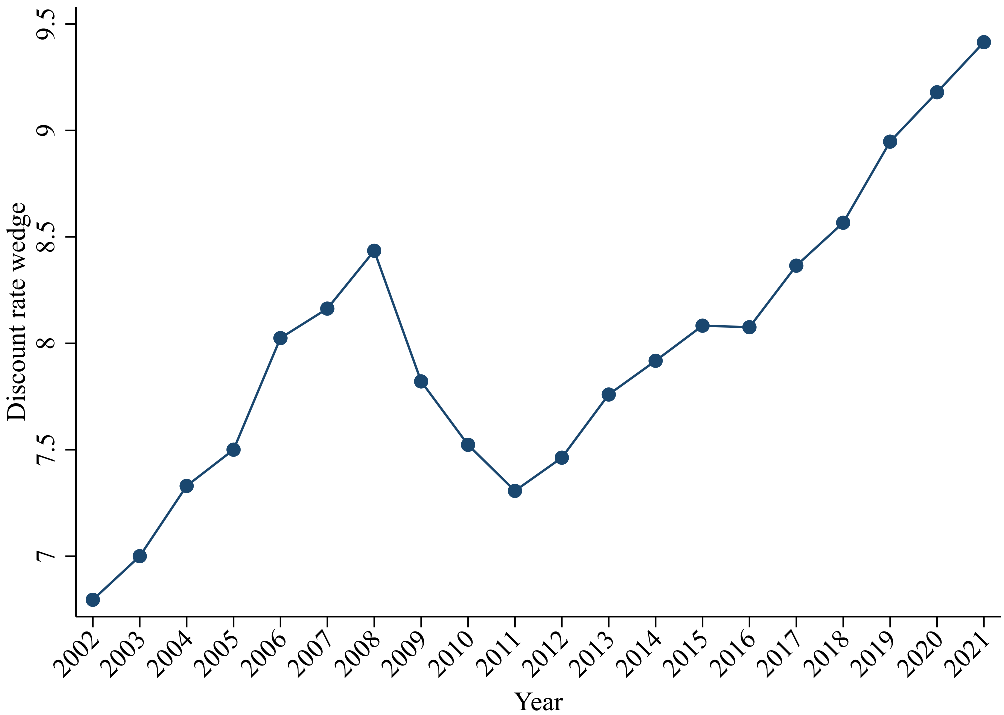


Figure 6
Discount Rates and Investment in the US

This figure plots the time series of average discount rates and aggregate net investment in the US. Investment is one year ahead relative to discount rates. We measure net investment using BEA data.

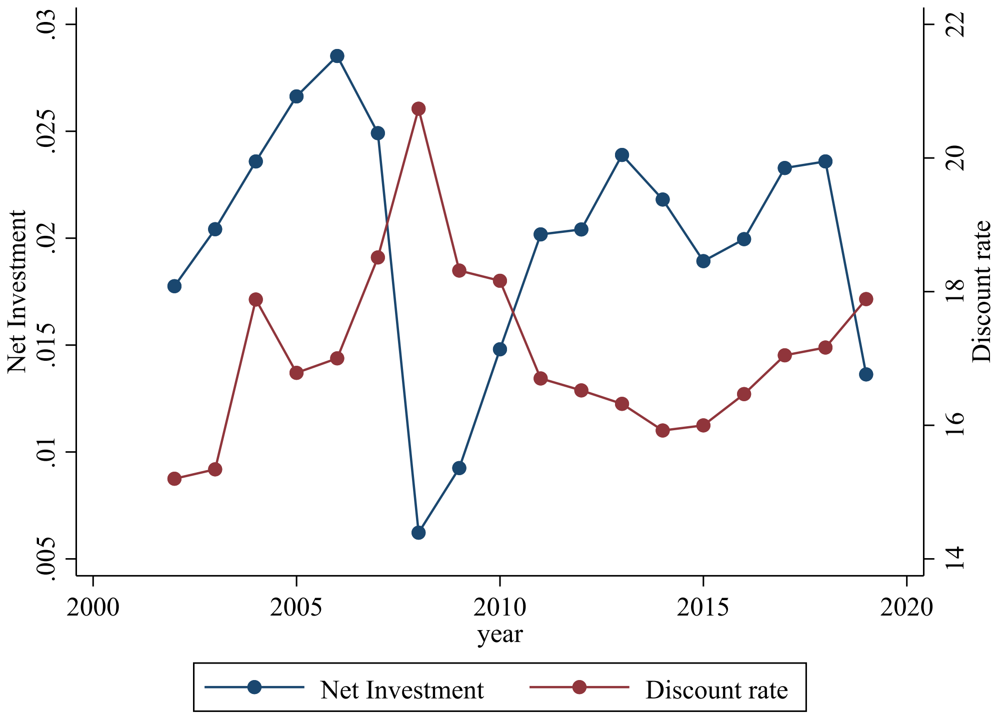


Figure 7
The "Adjusted Q"

This figure plots Tobin's Q as well as "Adjusted Q". Tobin's Q is calculated using flow of funds data as in Crouzet and Eberly (2022). Adjusted Q is calculated by adjusting Tobin's Q for the wedge between discount rates and the cost of capital, as explained in the text. The sample is the United States.

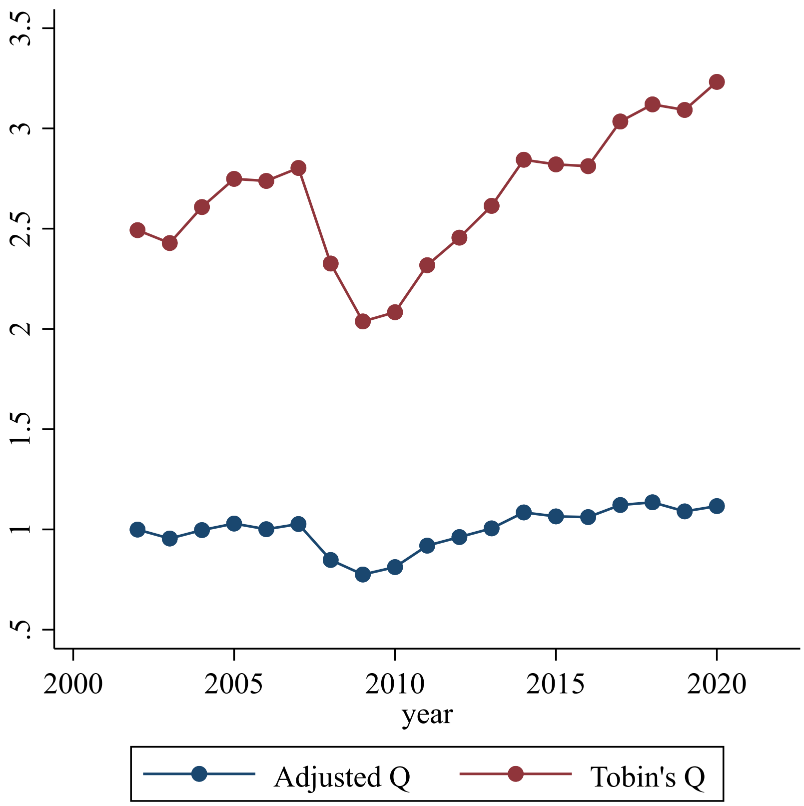


Figure 8
Adjusted Q and Missing Investment

This figure plots the cumulative investment shortfall in percent relative to the capital stock, calculated using Tobin's Q as well as adjusted Q. Tobin's Q is calculated using flow of funds data as in Crouzet and Eberly (2022). Adjusted Q is calculated by correcting Tobin's Q for the wedge between discount rates and the cost of capital, as explained in the text. We estimate the relation between investment and Q using the 1990-2002 sample and calculate cumulative residuals with respect to these out of sample. The pre-2002 adjusted Q is based on backwards extrapolated discount rate wedges (see text for details). The investment is aggregate investment, including intangibles, from BEA. The sample is the United States.

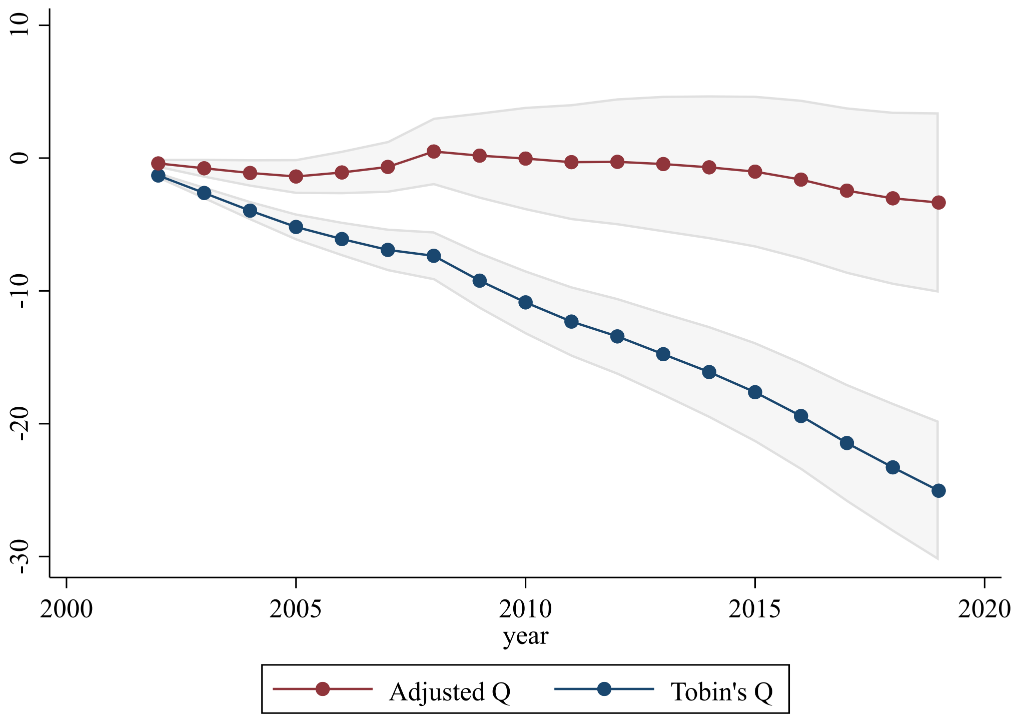
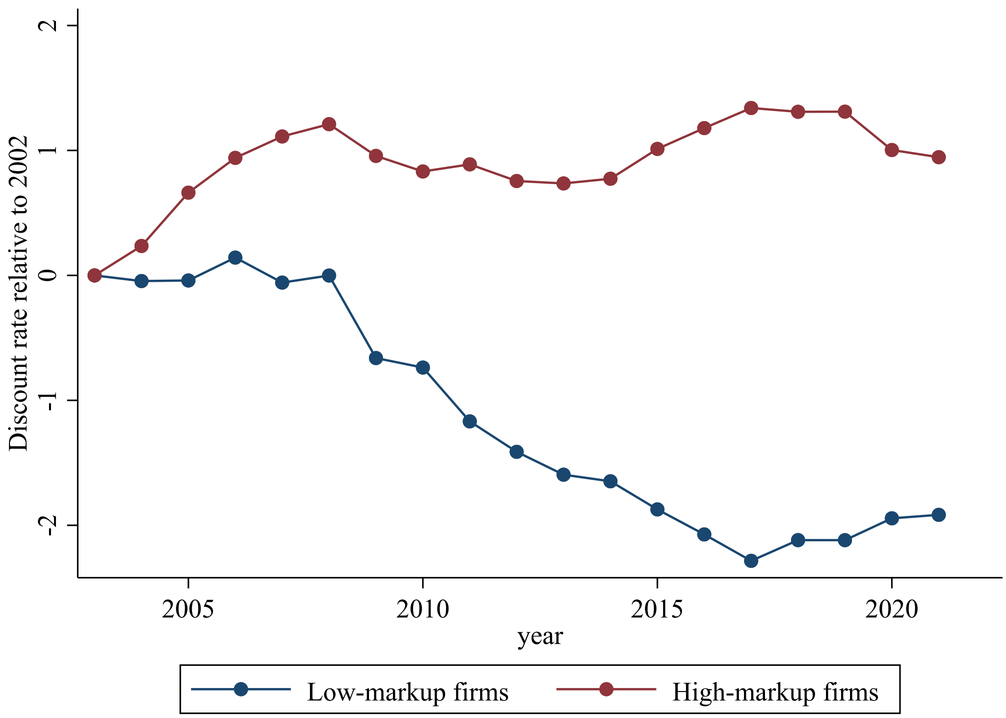


Figure 9
Market Power and Discount Rates

This figure plots the discount rates for high- and low-markup firms over time. We group firms into high- and low-markup firms based on the average markup of the firm in the 2000-2002 period. For each group we estimate the annual average annual discount rate in a panel regression using firm fixed effects. We smooth the resulting time-series for discount rates over three years and normalize both series to start at 0 in 2003. Markups are measured using as accounting profits using the method in Baqaee and Farhi (2020).



Online Appendix to "Corporate Discount Rates"

Appendix A Tables and Figures

Table A1
Investment and Corporate Discount Rates: Robustness 1 (Asset Expansion)

This table reports results of panel regressions of the firm-level investment rate on discount rates. We consider asset expansion measured as $I_t = \text{Assets}^i_{t+1}/\text{Assets}^i_t$. Right hand side variables are all measured at time t, as detailed in the text. Tobin's Q is measured as the book-to-market value of debt and equity. Standard errors are double-clustered by firm and date. The left- and right-hand side variables are measured in percentage points. Sample is 2002 to 2021 and excludes firms in the financial sector. Fin. cost of capital is the financial cost of capital estimated using the WACC and the CAPM.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Dependent variable: Asset Expansion					
Discount rate	-0.59*	-0.60**	-0.74***	-0.74**	-0.96**	-0.82**
	(0.28)	(0.25)	(0.25)	(0.27)	(0.37)	(0.37)
Financial WACC (firm-level)			0.61	1.03	1.42*	1.31
			(0.56)	(1.06)	(0.82)	(1.07)
Tobin's Q					3.07***	3.51***
					(0.80)	(0.72)
Observations	1,063	1,063	1,009	1,009	809	809
R-squared	0.432	0.476	0.446	0.492	0.552	0.600
FE	Firm	Firm/year	Firm	Firm/year	Firm	Firm/year
Cluster	Firm/year	Firm/year	Firm/year	Firm/year	Firm/year	Firm/year
Within R^2	0.0040	0.0042	0.0080	0.0095	0.081	0.10

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

Table A2
Investment and Corporate Discount Rates: Robustness 2 (Intangibles)

This table reports results of panel regressions of the firm-level investment rate on discount rates. We consider net investment including intangibles measured by R&D expenditure and capitalization of SGA. Right hand side variables are all measured at time t, as detailed in the text. Tobin's Q is measured as the book-to-market value of debt and equity. Standard errors are double-clustered by firm and date. The left- and right-hand side variables are measured in percentage points. Sample is 2002 to 2021 and excludes firms in the financial sector. Fin. cost of capital is the financial cost of capital estimated using the WACC and the CAPM.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Dependent variable: Net Investment Including Intangibles					
Discount rate	-0.27	-0.30**	-0.29	-0.32***	-0.50**	-0.45***
	(0.17)	(0.11)	(0.18)	(0.11)	(0.18)	(0.14)
Financial WACC (firm-level)			0.035	-0.26*	0.18	-0.17
			(0.19)	(0.14)	(0.23)	(0.16)
Tobin's Q					0.42***	0.47***
					(0.15)	(0.14)
Observations	956	956	911	911	764	764
R-squared	0.874	0.889	0.873	0.889	0.878	0.896
FE	Firm	Firm/year	Firm	Firm/year	Firm	Firm/year
Cluster	Firm/year	Firm/year	Firm/year	Firm/year	Firm/year	Firm/year
Within R^2	0.032	0.040	0.035	0.050	0.095	0.10

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

Table A3
Missing Investment

This table reports results of time-series regressions of net investment on Tobin's Q, the Adjusted Q, and variables capturing trends. We consider calendar year and a post-2002 dummy as right-hand side trend variables. Net investment is calculated from the BEA tables. The sample is 1990 to 2021. Adjusted Q in the pre-2002 sample is calculated based on a backward-extrapolated discount rate wedge as explained in the text. Standard errors are calculated using Newey-West adjusted for 5 lags. Regressions are annual.

	(1)	(2)	(3)	(4)
VARIABLES	Netinvestment	Netinvestment	Netinvestment	Netinvestment
Tobin's Q	2.02***	1.33***		
	(0.18)	(0.28)		
Adjusted Q			4.95***	4.72***
			(0.64)	(0.75)
Year	-0.09***		-0.02	
	(0.01)		(0.02)	
Post-2002 dummy		-1.28***		-0.31
		(0.26)		(0.29)
Observations	30	30	30	30
R-squared	0.77	0.67	0.74	0.72

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

Figure A1
Within-Firm Variation in Discount Rates and Cost of Capital

This figure plots the within-firm standard deviation of the perceived cost of capital (left) and discount rates (right). The sample is 2002 to 2021. We consider within-firm variation of all firms with more than 4 quarterly observations. The figure excludes firms for which discount rates and cost of capital are always constant.

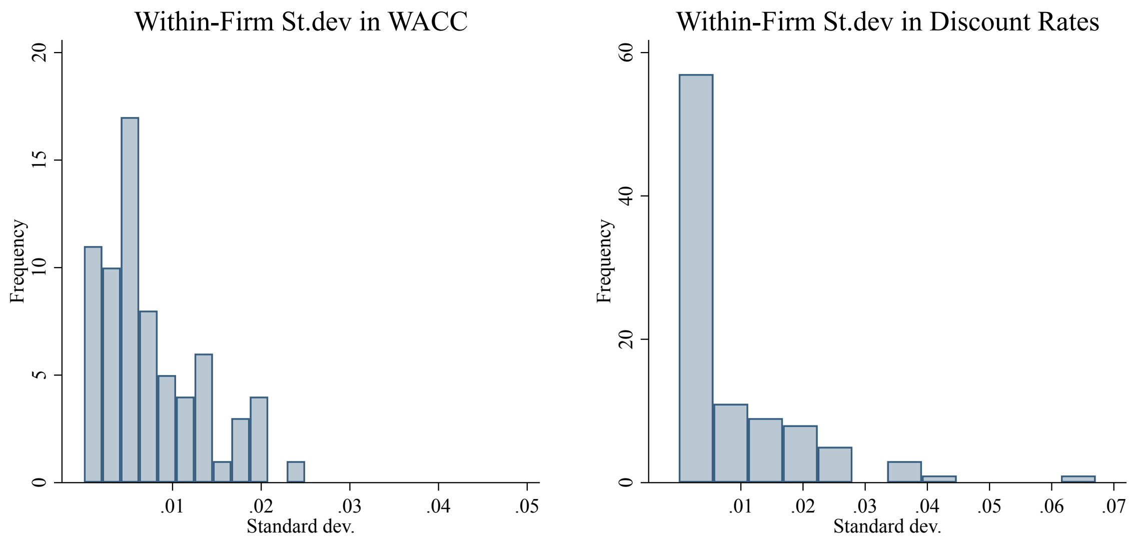


Figure A2
Tobin's Q, Adjusted Q, and Net Investment

This figure plots Tobin's Q and the Adjusted Q along with the Net Investment Rate. Net investment is calculated from the BEA tables. The sample is 1990 to 2021. Adjusted Q in the pre-2002 sample is calculated based on a backward-extrapolated discount rate wedge as explained in the text.

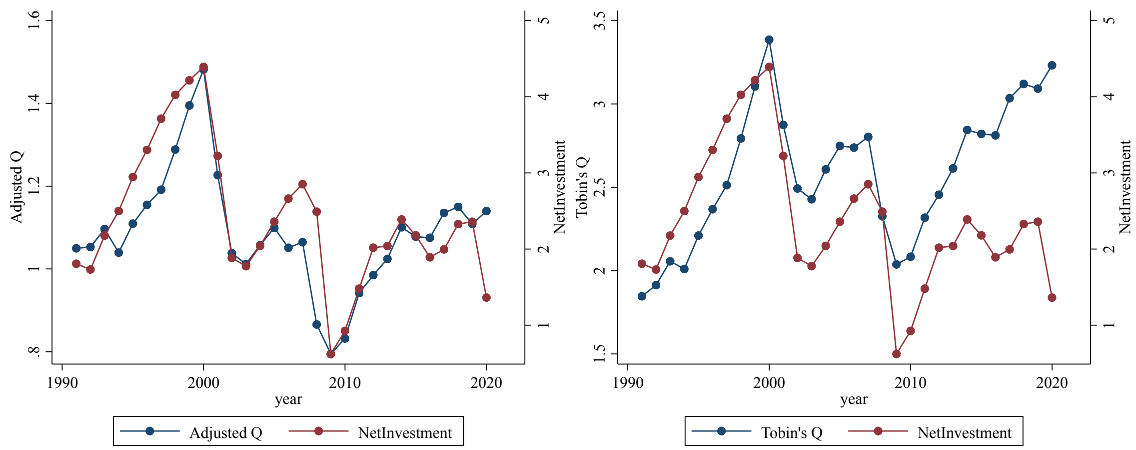
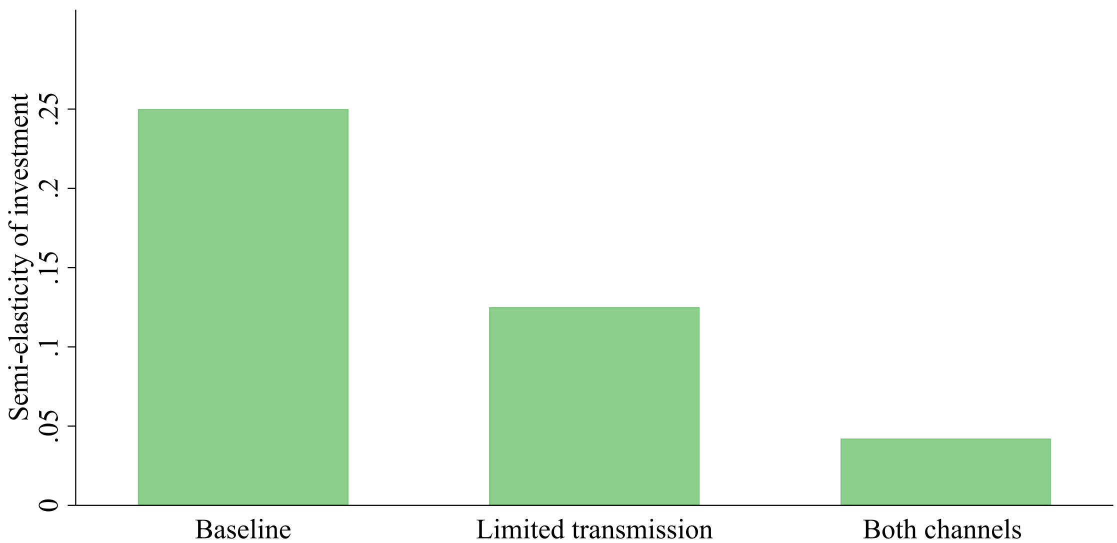


Figure A3
Investment sensitivities With and Without Discount Rate Wedges

This figure plots the sensitivity of the net investment rate with respect to the financial cost of capital. The leftmost bar shows the sensitivity in a standard model where the cost of capital and discount rate wedges are zero. The middle bar shows the sensitivity when incorporating only the impact of the ratio of discount rate to financial cost of capital. The right bar shows the sensitivity when also incorporating the duration effect.



Appendix B Details on Measurement

Appendix B.1 Extraction of Paragraphs from Conference Calls

The Thomson One database contains transcripts of conference calls held since January 2002. We download all calls in English that were available on September 9, 2021. Using an automatic text search algorithm, we identify relevant paragraphs in all 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 cost of capital, discount rates, and investment. 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, IRR. We identify roughly 74,000 of such paragraphs.

We match the firm name listed on Thomson One to Compustat by using a fuzzy merge algorithm, checking each match by hand. Ultimately, we link 88 percent of paragraphs to a Compustat firm. We combine the relevant paragraphs into data entry sheets of 500 paragraph each. To facilitate manual data entry, we include the date of the call, firm name, and blank columns for all financial figures of interest in the sheet. These figures are:

- 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

Appendix B.2 Data Entry Team

We read through each paragraph and enter the figures into the sheets. A total of 15 outstanding undergraduate research assistants contributed over the past two years. The average team size at any point in time was 5. Our research team met on a weekly basis to discuss individual cases and notes taken by the assistants and to coordinate on consistent guidelines.

We train each assistant. They learn about the basics of NPV methods and firm investment and read roughly 2,000 randomly selected paragraphs for training, which we then check and discuss manually. About two-thirds of the paragraphs were read twice, by different assistants, to minimize errors. The authors checked all outlier observations in the distribution of discount rates and changes in discount rates.

Appendix B.3 Guidelines for Manual Data Entry

We establish clear rules for which figures should be recorded. For the main analysis of this paper, we are interested in various ways that managers express discount rates (as hurdle rate, premium or fudge factor over the cost of capital, or required IRR) and their internally calculated, perceived cost of capital (as OCC or WACC). However, we include the larger set of terms listed above among the keywords and in the data entry sheets to ensure that our team differentiates required from expected and realized IRR as well as from various types of other returns. (The difference between how managers use the terms IRR and ROIC in practice is noteworthy. IRR usually refers to the marginal return on an individual project, while ROIC refers to operating profits relative to the entire value of capital on the firm's balance sheet.)

We do not record hypothetical numbers (e.g., "we may use a discount rate of x percent" or "for illustrative purposes, 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 used 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 general investment rules of the firm, as opposed to specific figures related to individual projects. For instance, we do not record the cost of capital 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 for most of the company's operations (e.g., US figures for a US company). We discuss all cases with multiple rates among the whole team.

Managers mostly discuss their unlevered, after-tax discount rate and cost of capital. We note when managers refer to levered and pre-tax discount rates (1.7 and 0.7 percent of discount rate observations, respectively) and to levered and pre-tax cost of capital (0 and 1.9 percent of cost of capital observations, respectively). We convert all observations into unlevered, after-tax values by estimating the average percentage point difference between levered and unlevered as well as after- and pre-tax observations, controlling for country-by-year fixed effects, and adjusting the values for the average 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 5 years and a 10 percent ROIC over the last 10.") 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 Details on Theory

Appendix C.1 Proof of Proposition 1

We know from (12) that

$$q_t = \frac{\delta V_t(\upsilon + \kappa, k_t)}{\delta k_{t+1}} = \frac{V_t(\upsilon + \kappa, k_t)}{k_{t+1}} = Q_t.$$

To estimate Q, we must calculate $V_t(\upsilon + \kappa, k_t)$. Note that $V_t(\upsilon + \kappa, k_t)$ is the value of the future profits produced by capital, calculated using $r^{\text{fin.}} + \upsilon + \kappa$ as the discount rate. If we set $\upsilon = \kappa = 0$, we get the value of these profits calculated using the cost of capital as the discount rates, $V_t(0, k_t)$, which is the value of the firms in the financial markets. We can approximate both using the Gordon growth model

$$V_t(0, k_t) \sim \frac{CF_{t+1}}{r - g}$$
$$V_t(\upsilon + \kappa, k_t) \sim \frac{CF_{t+1}}{r^{\text{fin.}} + \upsilon + \kappa - g}$$

where g is the long-run growth rate of free cash flows and CF_{t+1} is the free cash flow next period. Both of these variables are unobserved.

We can calculate the value of $V_t(\upsilon + \kappa, k_t)$ as

$$V_t(\upsilon + \kappa, k_t) = V_t(0, k_t)\frac{r - g}{r^{\text{fin.}} + \upsilon + \kappa - g} = V_t(0, k_t)\frac{1}{x \times \text{Dur} + 1} \tag{A1}$$

where Dur is the weighted average of the firms future cash flows, which in the Gordon growth model is given by:

$$\text{Dur} = \frac{1}{r - g}$$

(Gormsen and Lazarus 2022).

We can then calculate Q by inserting (A1) into (12) and using that

$$Q^{\text{Tobin}} = \frac{V_t(0, k_t)}{k_{t+1}}.$$

Alternative Formulation Without Duration

We can replace Dur in 13 with Tobin's Q and return on equity. Under the assumption that the firm is fully equity financed,

$$\frac{1}{\text{Dur}} = r - g = \frac{E}{P} = \frac{B}{M}\text{ROE} = \frac{\text{ROE}}{Q^{\text{Tobin}}}$$

such that

$$Q_t = Q^{\text{Tobin}}\frac{V_t(\upsilon + \kappa, k_t)}{V_t(0, k_t)} = Q^{\text{Tobin}}\frac{\text{ROE}}{x \times Q^{\text{Tobin}} + \text{ROE}}. \tag{A2}$$

Appendix D Adjusted Q and the Effect of Discount Rates on Investment

We use the model of adjusted Q in Section 4.2.1 to derive the relationship between investment and discount rates, given that there are wedges. We analyze how a change in the discount rate, which is exogenous to the cash flow of investment projects and adjustment costs, affects investment:

Proposition 2 (Investment and Discount Rates). *At the steady state, we observe the following relationship between investment and an exogenous shock to the discount rate:*

$$\frac{\Delta\left(\frac{I_t}{k_t} - \delta\right)}{\Delta(r^{\text{fin.}} + \upsilon + \kappa)} \sim \frac{-1}{\phi} \times \frac{\text{Dur}}{(\upsilon + \kappa) \times \text{Dur} + 1}. \tag{A3}$$

Proposition 2 follows from inserting Proposition 1 into equation 11 and taking the derivative with respect to the discount rate. It says that an increase in the discount rate decreases the value of future profits, the marginal value of capital, and thereby the incentive to invest. Two channels determine the strength of the effect. First, the duration of cash flows plays a role. If wedges are zero ($\upsilon + \kappa = 0$), the denominator of the right-hand side of Proposition 2 is equal to 1 and the effect solely depends on the duration relative to adjustment costs. Intuitively, investment is more responsive to discount rates if the duration is longer. The second channel plays a role if wedges are non-zero. With positive wedges, the duration is effectively shortened, which decreases the sensitivity of investment to discount rates.

To compare the model to the estimates, we assume a cash flow duration of 30 years, as is approximately the case for an unlevered firm (Gormsen and Lazarus 2022, van Binsbergen 2020), and that $\phi = 10$.[A1] The observed average discount rate wedge of 8 percentage points implies that the effect of discount rates on net investment is:

$$\frac{\Delta\left(\frac{I_t}{k_t} - \delta\right)}{\Delta(r^{\text{fin.}} + \upsilon + \kappa)} \sim \frac{-1}{10} \times \frac{30}{0.08 \times 30 + 1} \sim -0.88,$$

which is in line with our empirical estimates that lie between -0.8 and -0.9.

[A1] The assumption $\phi = 10$ is based on Philippon (2009), who discusses various estimates used in the literature.