Discount Rates:
Measurement and Implications for Investment[*]

Niels Joachim Gormsen and Kilian Huber

April 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 empirical 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 financial cost of capital, but the relationship is not one-to-one, leading to time-varying wedges between discount rates and the cost of capital. Discount rates are negatively related to future investment, even after controlling for the cost of capital, with a magnitude close to that predicted by theory. Adjusting Tobin's Q for discount rate wedges lowers the capital adjustment costs implied by Q-theory. The adjustment to Q partially accounts for low investment rates (relative to high asset prices) in recent decades. We explore the drivers of discount rate wedges and find that risk, organizational frictions, and market power all play a role.

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 payoffs 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 30 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. Standard models typically assume that firms use the cost of capital from financial markets as the discount rate, implying that investment responds sharply to financial fluctuations. In practice, however, a firm's choice of discount rate need not equal the financial cost of capital. The corporate finance literature has outlined conceptually why the two might differ and surveys show that the levels of discount rates often exceed the financial cost of capital (Poterba and Summers 1995, Jagannathan et al. 2016, Graham 2022). Moreover, even if firms would like to use the financial cost of capital as the discount rate, firms' perceived cost of capital is likely to differ from the true financial cost of capital, since the latter is not directly observed and difficult to estimate.

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 partially incorporate changes in their perceived cost of capital into discount rates, but the relationship is weaker than in standard models. Discount rates are negatively related to future investment, both at the firm and country level, with a magnitude close to that predicted by theory. The relation between discount rates and investment is stronger than the relation between cost of capital and investment and it is robust to controlling for Tobin's Q. The behavior of discount rates across firms and over time sheds light on several investment puzzles, such as the low sensitivity of investment to capital costs, the weak relationship between investment and Tobin's Q, and the origins of low US investment rates 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,

---

[1]This model is calibrated using the adjustment cost specification in Philippon (2009) and the observed values of Tobin's Q and the financial cost of capital in the United States since 2000.

managers sometimes reveal their firms' discount rates and their perceived cost of capital as a way of providing transparency to the capital budgeting process.[2] We collect transcripts 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 directly estimate 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 equity tracks a financially sophisticated measure of the cost of equity (CAPE), albeit one that assumes stronger growth than historically observed. This result implies that firms dynamically update their cost of capital as expected stock returns change, in line with standard finance theory.

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

---

[2]The discount rate is the rate at which the firm values future cash flows and which enters the net present 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, as discussed in detail in Section 2.1. We therefore use the terms discount rate, hurdle rate, and required internal rate of return interchangeably for the purpose of our data collection.

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. This pattern gives rise to a time-varying wedge between discount rates and the cost of capital. For the US, this wedge has expanded dramatically over the last two decades as the cost of capital has decreased while discount rates have been relatively stable. We will later explain how this wedge is important for our understanding of the link between financial markets and investment, but before doing so, we address the relationship between discount rates and 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 -0.9 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 turn to the implications of discount rate wedges for our understanding of the link between financial markets and investment. We emphasize three implications. First, discount rate wedges lower the sensitivity of investment with respect to the financial cost of capital. The reduced sensitivity is partly driven by the partial (not one-to-one) pass-through of shocks to the financial cost of capital to discount rates. In addition, it is further amplified by the mechanical effect of higher discount rates on the duration of cash flows (i.e., high discount rates make cash flows far in the future less valuable and thereby make the discounted sum of all cash flows less sensitive to discount rates). 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).[3]

The second implication concerns Q-theory. The presence of discount rate wedges implies that firms use higher discount rates than financial markets. Using financial market data to infer firms' discount rates and investment incentives may thus be misleading. This is important for Q-theory, which uses financial markets to measure the value of an additional unit of capital through Tobin's Q. We introduce an "adjusted Q," which adjusts Tobin's Q using observed discount rate wedges, such that the resulting Q represents the shadow value

---

[3]See Christiano et al. (2005), Khan and Thomas (2008), Bachmann et al. (2013), House (2014), Koby and Wolf (2020), Winberry (2021).

of an additional unit of capital in the eyes of the firm. Adjusted Q for the aggregate market is close to 1 throughout our sample, as Q-theory would predict. In addition, the adjusted Q predicts investment slightly better than Tobin's Q in the cross section of US firms, and it produces slope coefficients that are substantially higher than those for Tobin's Q. The high slope coefficients mean that adjusted Q implies much more reasonable adjustment costs than Tobin's Q, thus shedding light on some of the puzzles regarding Tobin's Q and investment (Summers 1981, Bond and Van Reenen 2007, Philippon 2009).[4]

The third implication of discount rate wedges is that they inform the debate about "missing investment" in the 21st century. Gutiérrez and Philippon (2017) show that the growing value of Tobin's Q in the 21st century, combined with modest investment rates, imply cumulative investment shortfalls exceeding 10% of the aggregate capital stock. Intuitively, firms have not increased investment rates, despite equity market booms and low interest rates. We find that the wedge between discount rates and the cost of capital continually widened in this period, which means that Tobin's Q has become an increasingly misleading measure of the shadow value of capital in the eyes of firms. When instead considering the relationship between investment and adjusted Q, we find cumulative investment shortfalls closer to zero. This finding does not imply that there is no missing investment relative to the standard benchmark. What it does imply, however, is that discount rate wedges are large enough to account for a large fraction of the missing investment. Understanding the drivers of discount rate wedges is likely a fruitful avenue for our understanding low investment rates.[5]

We explore the drivers of discount rate wedges in the final part of the paper. We find that firms facing higher risk and organizational constraints set higher discount rates, conditional on the cost of capital.[6] These results are consistent with manager statements on conference calls as well as theories about real options, agency costs, and managerial frictions (McDonald 2000, Jagannathan et al. 2016). While these results address the high average level of discount rates, they do not explain why discount rates have not decreased with the cost of capital in

---

[4]Our findings leave open the possibility that other factors also play a role in explaining the shortcomings of Tobin's Q, including mismeasured Q (Erickson and Whited 2000), mismeasured intangible investment (Hall 2001, Eisfeldt and Papanikolaou 2013, Crouzet and Eberly forthcoming) and non-convex adjustment costs (Abel and Eberly 1994, Caballero and Engel 1999).

[5]The presence of time-varying wedges between the cost of capital and discount rates also informs the debate about rising "factorless income" (Karabarbounis and Neiman 2019, Rognlie 2019).

[6]Caballero et al. (2017) and Farhi and Gourio (2018) also find that risk has affected corporate investment due to financial risk premia. However, we emphasize that risk can influence investment through higher discount rate wedges set by firms rather than just through risk premia. More generally, Bloom (2009) and Baker et al. (2016) emphasize that risk and uncertainty affect investment and that uncertainty has gone up in recent years.

recent years, thereby leading to an increase in discount rate wedges. We find that the wedge has mostly increased for firms with high market power but remained stable for firms with less market power. This suggests that competitive forces have an important disciplining role in the determination of discount rates and investment. Firms without market power struggle to generate value if they use high discount rate wedges, while firms with market power can let wedges grow without such pressures.[7]

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 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 discount rate 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 approximate complicated investment problems (McDonald 2000). Consistent with these models, Sharpe and Suarez (2020) report survey evidence that some managers do not intend to adjust their discount rates when interest rates change. Finally, other factors apart from net present value calculations might affect investment in practice, unlike in simple investment models (Graham 2022). We contribute by providing direct evidence on each of these three conditions, allowing us to evaluate their empirical relevance.

---

[7]Philippon (2019), De Loecker et al. (2020), and Liu et al. (2022) argue that rising market power has lowered investment in recent decades. We extend this view by arguing that even a stable level of market power can lower investment because firms with market power are less likely to incorporate decreases in the cost of capital into their investment decisions.

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, using estimates of wedges based on knowledge about managerial behavior; 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 Theory

This section models the relationship between firm investment and discount rates. The model is closely related to the standard Q-model but differs in that it allows for a wedge between the discount rates used by firms and the cost of capital on financial markets. Standard theory often assumes that firms use the financial cost of capital as discount rate because doing so maximizes shareholder value. In practice, however, firms add wedges on top of the cost of capital to obtain their discount rates. There are many reasons why firms might add such wedges, for example to approximate optimal solutions to complex maximization

problems (McDonald 2000) or as a result of agency issues (see Section 5). For the purpose of the model, we treat discount rate wedges as exogenous and later discipline the model by measuring the wedges in the data.

The firm chooses the optimal investment level I_t by maximizing the discounted value of future profits net of investment costs. The firm's discount rate is given by $r + x$, where $r \in \mathbb{R}^+$ is the cost of capital on financial markets and $x \in \mathbb{R}^+$ is a wedge between the cost of capital and the discount rate. We model the investment problem as

$$V_t(x, k_t) = \max_{I_t} \quad \sum_{t=0}^{\infty} \frac{\Pi_t(k_t) - I_t - \Phi(I_t, k_t)}{(1 + r + x)^t} \tag{1}$$

$$\text{s.t.} \quad k_{t+1} = I_t + (1 - \delta)k_t \tag{2}$$

where $\Pi_t(k_t)$ is profits earned at time t net of labor cost using k_t units of capital and the optimal units of labor, I_t is investment at time t, δ is the depreciation rate of capital, and $V_t(x, k_t)$ is the value of the firm at time k, calculated using the discount rate $r + x$. The function $\Phi(I_t, k_t)$ captures adjustment costs, which are assumed to be quadratic in net investment:

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

where $\phi \in \mathbb{R}^+$ governs the magnitude of adjustment costs.

Solving the model as a constrained optimization problem (see Appendix for derivations) gives the following expression for optimal investment,

$$\frac{I_t}{k_t} - \delta = \frac{1}{\phi}(q_t - 1). \tag{3}$$

Here, q_t is the lagrange multiplier from the maximization problem in (2), capturing the marginal value of an additional unit of capital:

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

Taken together, the above expressions tell us that firms should expand capital whenever the marginal value of an additional unit of capital, q_t, exceeds 1. The pace at which they should do so depends on the adjustment cost ϕ.

The marginal value of capital q_t is not observable without additional assumption. The literature usually follows Hayashi (1982) and assumes that the production function and the

7

cost function are both homogeneous of degree one. In this case, the marginal value of capital equals the average value of capital, denoted Q_t,

$$q_t = \frac{\delta V_t(x, k_t)}{\delta k_{t+1}} = \frac{V_t(x, k_t)}{k_{t+1}} = Q_t. \tag{4}$$

Based on these assumptions, we can thus measure q_t as the value of total capital relative to its replacement value. We emphasize that $V_t(x, k_t)$ is calculated using $r + x$ as the discount rate. If $x = 0$, such that the firms uses the cost of capital as the discount rate, we can estimate this value on financial markets using Tobin's Q. However, when $x \neq 0$, one must make a correction to Tobin's Q to obtain the marginal value of capital in the eyes of the firm, q_t, as summarized in the next proposition.

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

$$q_t \sim Q_t^{\text{Tobin}} \times \frac{1}{x \times \text{Dur} + 1} \tag{5}$$

where Dur is the duration of the firm's future cash flows as defined in the Appendix. Proof is in the Appendix.

Proposition 1 shows that we can approximate marginal q as Tobin's Q times an adjustment. If the discount rate wedge x is equal to 0, such that firms use their cost of capital as their discount rate, the adjustment term is one and q is equal to Tobin's Q. Intuitively, firms and financial markets use the same discount rates in this case and therefore agree on the value of the profits produced by capital. However, when $x > 0$, as is the case empirically, we must adjust Q downwards because the firm uses a higher discount rate than the market, leading the firm to put a lower value on capital than the market does. The strength of the adjustment naturally depends on how much x deviates from 0, but it also depends 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 flows are earned), the larger the effect of discount rates on the value of the asset. For this reason, the effect of discount rate wedges increases in the duration of the firm's cash flows.

We next address the relationship between investment and changes in discount rates. We do so by making a partial equilibrium statement about changes in discount rates that are unrelated to changes in future expected profits and adjustment costs. The proposition follows from inserting Proposition 1 into (3) and taking the derivative with respect to the discount rate.

Proposition 2 (Investment and Discount Rates). *At the steady-state, we observe the following relationship between investment and a shock to $x + r$ that is orthogonal to earnings:*

$$\frac{\Delta\left(\frac{I_t}{k_t} - \delta\right)}{\Delta(x+r)} \sim \frac{1}{\phi} \times \frac{\text{Dur}}{x \times \text{Dur} + 1}. \tag{6}$$

Proposition 2 shows that investment decreases when r increases. The increase in the discount rate decreases the value of the future profits produced by capital, decreasing the marginal value of capital and thereby the incentive to invest. The strength of the effect again depends on the duration of the cash flows. In the absence of discount rate wedges, the denominator is equal to 1 and the effect is given by the duration divided by the adjustment costs, with the effect of discount rates on investment again being stronger the longer the duration. However, if $x > 0$, the denominator is bigger than 1 and the effect of discount rates becomes muted. The reason is that $x > 0$ effectively shortens the duration of $V_t(x, k_t)$, thereby decreasing the sensitivity of investment to discount rates.

In conclusion, the above model shows that optimal investment is directly related to the discount rate. If this discount rate is equal to the cost of capital, there is a strong relationship between optimal investment and the market value of the firms asset (Brainard and Tobin 1968, Tobin 1969). If there is a wedge between the cost of capital and the discount rate, this wedge influences the relationship between investment and financial markets.

2 Measurement

The previous section suggests that investment depends crucially on the discount rate, which itself may be influenced by the perceived cost of capital. These capital budgeting rates are part of firms' internal calculations and not observed in publicly available reports and datasets. One contribution of this paper is to jointly measure listed corporations' perceived costs of equity, debt, and capital, discount rates, and investment in one new database.

2.1 Intuitive Interpretation of Capital Budgeting Rates

It is useful to give an intuitive definition of perceived cost of capital and discount rates, so we can identify them in managers' speech. The perceived cost of capital is the weighted average cost of equity and debt, as calculated by the firm. It is given by r in the theory of equation 2 and in practice is calculated as

$$r_t = \omega_t \times (1 - \tau) \times r_t^{\text{debt}} + (1 - \omega_t) \times r_t^{\text{equity}} \tag{7}$$

where r_t^{debt} and r_t^{equity} are the cost of debt and equity for firm i at time t, τ is the tax rate, and ω_t is the leverage ratio defined as the market value of debt relative to the market value of debt plus equity.

In standard models, the discount rate is the rate at which the firm values future cash flows and which enters the net present value (NPV) calculation of its projects. It is represented by $r + x$ in the theory section. While the discount rate determines how much the firm values future cash flows, it can also be thought of as the lowest return the firm is willing to accept on its investments. Indeed, the optimizing firm invests in projects where the NPV is above zero. The expected rate of return on a project exactly equals the discount rate if the NPV is zero and exceeds the discount rate if the NPV is positive. In practice, rather than using the term discount rate, firms often discuss a minimum internal rate of return (IRR) that they are willing to accept, also known as hurdle rate. For our analysis, the terms discount rate, minimum IRR, and hurdle rate all capture the same concept (see also Jagannathan et al. 2016).[8]

2.2 Measuring Capital Budgeting Rates

We measure capital budgeting rates at the firm level using corporate earnings conference calls. The majority of listed corporations hold conference calls every quarter, so that managers can inform financial analysts, investors, and other observers about the firm's strategy.

We download all transcripts of conference calls for the period January 2002 to September

---

[8]In line with standard theory, finance textbooks recommend that firms should use net present value to make investment decisions. 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 decision method involves comparing a project's IRR to the minimum IRR. The two methods may rank mutually exclusive projects differently and thus lead to different project choices. Since we are concerned with total investment and not choices between individual projects, the ranking is not key for our analysis.

2021 available on the Thomson One database. We identify all paragraphs that contain at least one keyword related to capital budgeting as well as one of the words "percent," "percentage," or "%".[9] It is difficult to train an automatic text reading algorithm to identify the relevant objects, as context and background are of the essence. Instead, we trained a team of research assistants to manually extract the relevant variables from the text.

To measure financing costs, we use paragraphs where managers state their perceived, contemporaneous costs of equity, debt, and capital. These figures come from firms' internal calculations, potentially relying on financial asset prices and interest rates. We are careful not to record previous or speculative costs. We also consider abbreviations, such as WACC, and synonyms, such as required return on equity and debt rate, as long as the managers clearly relate them to financing costs.

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. In addition to the capital budgeting figures, we record a range of other financial variables based on managers' statements on the conference calls, including required, expected, and realized returns on assets, on invested capital, and on equity.

We generally restrict the data collection to figures representative for the firm overall. For example, if the manager of a mining company refers to the cost of debt from a particular bond issuance and the expected return on assets from an individual mine, we do not record these figures. A handful of firms mention multiple discount rates in the same paragraph, for example varying by country. We record the rate that represents most of the firm's operations.

Overall, the team read over 55,000 distinct paragraphs over the span of roughly 20 months. To ensure high quality and consistency across research assistants, we had weekly team meetings where we discussed specific paragraphs. Most paragraphs were read by two

---

[9]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.

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.

2.3 Measuring Financial Data

We amend the data from conference calls with additional databases. Firm-level accounting data are from Compustat XpressFeed, stock prices from the Center for Research in Security Prices tape, and the implied volatility of stock returns from OptionMetrics. We focus our analysis on countries appearing in the MSCI Developed World Index.

We also construct the cost of capital on financial markets. We calculate the cost of debt using interest expenses in Compustat. The cost of equity is more complicated, as it is the firm's long-run expected stock return. We first estimate long-run expected stock returns at the country level, as explained below, and then calculate the cost of equity using the CAPM model. We obtain marginal tax rates from Valueline for US firms and assume a tax rate of 30% for non-US firms or firms that are not in Valueline.

We calculate long-run expected stock returns at the country level using two different methods. For the US, we use the earnings yield based on the CAPE measure from Robert Shiller. In the Gordon growth model, the yield is equal to the long-run expected stock return minus the long-run expected growth rate. We calculate expected stock returns by assuming a long-run real growth rate of 2% (which is the average growth rate for the 20th century) and a long-run inflation rate of 2%. Outside the US, it is more complicated to calculate the earnings yield as we do not observe the CAPE.[10] Instead, we calculate expected stock returns using the out-of-sample methods in Campbell and Thompson (2008), focusing on the book-to-market, earnings-to-price, and dividend-to-price measures as described in that paper. Our final measure of expected stock returns averages across the three.[11]

2.4 Summary Statistics

The new dataset measures capital budgeting rates for a diverse set of listed firms. Market value in the data ranges from 291 million USD at the 5th percentile to 51,536 at the 95th

---

[10]The CAPE measure is based on prices relative to average earnings over the last 10 years. Calculating average earnings over such long periods requires well-defined indexes that are stable in terms of constituents and composition, such as the S&P 500, but such stable stock indexes are not always available in foreign countries.

[11]As input to these, we estimate average return on equity and average payout ratios in the given countries. This differs from Campbell and Thompson (2008), who use rolling ten-year average in their US application. As discussed above, we refrain from calculating ten-year averages outside the US due to data limitations.

(Table 1, panel A). The data include some of the world's largest corporations, including AT&T, Bank of America, Disney, 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 dataset reveals roughly 8,300 capital budgeting rates (including perceived costs of equity, debt, and capital and discount rates) for roughly 2,400 unique firms. The average perceived cost of equity is 10.5%, cost of debt is 4.6%, cost of capital is 8.9%, and discount rate is 15.8% (nominal values in Table 1). The perceived cost of capital is distributed fairly symmetrically, while discount rates are more dispersed (Figure 1).

We study whether firms with observed capital budgeting rates are similar to other firms in Compustat between 2002 and 2021. We collapse the data at the firm level and include an indicator variable for whether a given firm is included at one point in our sample. In panel B of Table 1, we regress the indicator variable on a set of firm-level regressors. The regressors are the firm's percentile rank, relative to other firms in its country in the same year, in the distribution of return on equity, market value, and book-to-market ratio. The variable that most strongly predicts inclusion is market equity, with large firms more likely to be included. While small firms are relatively unlikely to be included, we observe many of the largest firms in the economy. For instance, while the unconditional probability of inclusion if around 4%, we observe 50% of the 100 largest firms in the US. More profitable firms are also more likely to be included, but this result is driven by the fact that larger firms are more profitable (profitability drops once including market equity on the right hand side). Book to market and investment rates does not, unconditionally, predict inclusion.

3   The Cost of Capital, Discount Rates, and Investment

In this section, we explore how firms' perceived cost of capital and discount rates are determined and how they relate to investment. Figure 2 uses the new dataset to plot raw averages of firms' perceived cost of debt, perceived cost of capital, and discount rates in the US by year. The figure shows that both the cost of debt and the cost of capital have trended downward since 2002. Discount rates exceed the cost of capital and do not display a clear downward trend.

The figure raises a number of questions. Is the trend in perceived cost of capital consistent with developments on financial markets? Are changes in the cost of capital incorporated into

discount rates? And how do discount rates affect investment? We address these questions in turn. We begin by providing macro evidence at the level of countries before turning to more fine-grained firm-level analyses.

3.1 The Perceived Cost of Capital and Financial Markets

We start by studying how the cost of equity and the cost of debt is reflected in firms' perceived cost of capital, using data at the country-year level. We measure the cost of equity on financial markets as the long-run expected stock return in a country at a given time, estimated as explained in Section 2.3. We measure the cost of debt as firms' average perceived cost of debt at a given time, as the perceived cost of debt closely follows realized interest rates. We weight regressions by the number of observations in each country at a given point in time.[12]

Table 2 shows the results of regressions of the cost of capital on the cost of debt and expected stock returns. The cost of capital is strongly related to expected stock returns, particularly once we include country fixed effects in columns 2 and 3. The coefficient on expected stock returns is around 0.5 with country fixed effects, which is only slightly below what we would expect given that firms use roughly 2/3 equity financing. The coefficient on the cost of debt is just below 0.3 with country fixed effects in column 2. There is little variation in the cost of debt once we control for country and year fixed effects in column 3, rendering an imprecise estimate in that specification.

It is ex ante unclear whether firms correctly incorporate variation in expected stock returns into their perceived cost of equity. Expected stock returns are difficult to estimate, making financial economist disagree on what expected stock returns are and whether they are even predictable (Stambaugh 1999, Welch and Goyal 2008, Campbell and Thompson 2008, Campbell and Yogo 2006). On top of that, MBA students are often taught to assume a constant equity risk premium of 6%, which would lead them to incorrectly vary their perceived cost of equity over time (Cochrane 2011).

To illustrate the range of potential estimates for the cost of equity, Figure 3 plots US firms' perceived cost of equity along with three alternative estimates of long-run expected stock returns. The green line simulates the estimate of an MBA student assuming a constant equity risk premium of 6%. The two red lines use more sophisticated estimates based on the CAPE measure maintained by Robert Shiller. One of these is our baseline estimate of

---

[12]The weight for country i at time t is the number of observations in country i at time t relative to all observations at time t.

expected returns in the US, namely the earnings yield plus a nominal growth rate of 4% (the historical average, see Section 2.3). The other estimate is the earnings yield plus a bullish expected growth rate of 6%. The three methods lead to substantially different estimates of the cost of equity. The perceived cost of equity reported by firms is most closely aligned with the estimate based on CAPE and a high growth rate.

Overall, the results suggest that firms incorporate variation in expected stock returns into their cost of equity and thereby cost of capital. As an example of this behavior, this section ends with a quote from the CFO of IAG (the parent company of British Airways and Iberian) who on a conference call in 2014 shares his thoughts about their perceived cost of equity. The quote suggests that IAG increased their cost of equity in response to the sovereign debt crisis in Europe in 2011 and subsequently lowered the premium as the crisis resolved:

2014-11-07, IAG, Enrique Dupuy, CFO: *"... we are still keeping a cost of capital of 10% 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% level. But I think the assumptions are now behind ... the 15% cost of equity, it appears to have a big, big premium there. Maybe those figures could be brought down slightly so 10%, 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 next study how discount rates are related to the perceived cost of capital across countries and across time. To this end, Table 3 reports regressions of discount rates on the contemporaneous cost of capital, both averaged at the country-year level. We find a slope coefficient of 0.83 in a specification without controls, which suggests that countries with higher perceived cost of capital also have higher discount rates. The coefficient is significant at the 1% level. To illustrate this result, Figure 4 plots the average discount rate and perceived cost of capital for the ten countries with most observations. The relationship is close to linear, with the exception of Australia, for which discount rates appear low relative to the cost of capital. Discount rates lie well above the cost of capital in all countries.

The second column in Table 3 includes country fixed effects and thereby explores whether time variation in the perceived cost of capital is incorporated into discount rates. The slope

coefficient remains significant but drops to 0.39, implying that a 1 percentage point increase in the cost of capital raises discount rates by 0.39 percentage points. In the third column, we include country and year fixed effects. The slope coefficient is 0.32 and statistically significant at the 10% level. Taken together, these results suggest that firms incorporate changes in the perceived cost of capital into discount rates, but that they do so less than one-to-one.[13] The following quote from a Fortune 500 CFO offers an example of such behavior:

2014-09-17, Spectra Energy, John Patrick Reddy, CFO: *"Well, one thing I'd just offer is that 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%. We didn't take our hurdle rates down to 5%, for example. We are still looking at returns of, say 10%, on average for our projects."*

The partial pass-through of the cost of capital gives rise to discount rate wedges (represented by x in Section 1). Figure 5 shows that the average wedge in the US varies over time. We estimate the average wedge in each year using firm-level panel regressions that control for firm fixed effects. The wedge is around 8 percentage points on average and has trended upward throughout the sample, with some variation around the global financial crisis. We document in Section 4 that the existence and behavior of this wedge has important implications for the link between investment and financial markets. Section 5 explores the mechanisms driving the wedge.

3.3   Aggregate Investment and Discount Rates

Aggregate net investment in the US is positively correlated with the average discount rate reported by firms in the previous year, as shown in Figure 6. The raw correlation between the two series is -0.51. This pattern suggests that discount rates comove with investment, as predicted by standard theory.

We analyze this relationship in more detail using data at the country-year level in Table 4. We regress aggregate net investment on the average discount rate in the country and year. Aggregate net investment is measured in Compustat as total capital expenditure net of depreciation divided by the lagged net value of property, plant, and equipment. The

---

[13]In Section 5.2, we conduct a similar exercise at the firm level. Firm-level point estimates are slightly higher, around 0.6, but confirm the conclusion of partial pass-through. There is likely some measurement error in the country-year averages, which could explain the slightly different point estimates.

coefficient on discount rates is statistically significant and implies that a percentage point increase in discount rates is associated with a -0.27 percentage point change in investment, conditional on country fixed effects. The coefficient remains the same when we add year fixed effects in column 2. The within-R^2 is 12% when including year fixed effects, consistent with discount rates potentially playing an important role in aggregate investment fluctuations.

The association between discount rates and aggregate investment is robust to controlling for the financial cost of capital in columns 3 and 4. This suggests that the importance of discount rates is not only driven by the relationship between discount rates and financial markets.[14] The results are also robust to controlling for Tobin's Q in columns 5 and 6, which is a sufficient statistic for investment in a standard model without discount rate wedges.

3.4   Firm-Level Investment and Discount Rates

We next study the relationship between discount rates and investment at the firm level. Firm-level data allow us to explore more variation in discount rates and to control for common shocks more comprehensively.[15]

Table 5 reports regressions of firm-level net investment, measured in Compustat, on firm-level discount rates. All regressions include firm fixed effects, so estimates are driven by within-firm variation in discount rates and investment. Across a range of specifications, we find slope coefficients around -0.9. This estimate is well above the country-level estimate, potentially reflecting general equilibrium effects. The estimate is stable when we add year fixed effects in column 2. Controlling for the financial cost of capital does not affect the coefficient in columns 3 and 4. Further augmenting the regression with measures of profitability, such as return on equity and Tobin's Q, raises the point estimate slightly in columns 5 and 6.

The size of the coefficients is close to what we could expect from Proposition 2, which says that

$$\frac{\Delta\left(\frac{I_t}{k_t} - \delta\right)}{\Delta x + r} \sim \frac{1}{\phi} \times \frac{\text{Dur}}{x \times \text{Dur} + 1}.$$

---

[14]The relationship between the cost of capital and investment is highly dependent on whether or not we include time-fixed effects, potentially because the cost of capital is driven by many variables that also affect investment, such as shocks to future productivity.

[15]We explore the drivers of firm-level discount rates in Section 5.

Assuming[16] $\phi = 10$ and a cash-flow duration of 30 years, as is approximately the case for an unlevered firm (Gormsen and Lazarus forthcoming, van Binsbergen 2020), the observed average discount rate wedge of 8 percentage points implies that the effect of discount rates on net investment is

$$\frac{\Delta\left(\frac{I_t}{k_t} - \delta\right)}{\Delta(x+r)} \sim \frac{1}{10} \times \frac{30}{0.08 \times 30 + 1} \sim -0.88.$$

This value is close to our empirical estimate of -0.9. We caution, however, that our empirical estimate has a causal interpretation only if we believe that discount rates are orthogonal to unobserved investment opportunities and profitability.

4   Implications of Discount Rate Wedges

The previous section documents substantial wedges between corporate discount rates and the cost of capital. In this section, we study the implications of these wedges for our understanding of the relationship between investment and financial markets.

4.1   Investment Sensitivities with Discount Rate Wedges

The presence of discount rate wedges reduces the expected strength of the relationship between investment and the cost of capital. Two channels are at play. To understand these two channels, note that we can approximate the effect of the cost of capital on net investment (following Proposition 2) as

$$\frac{\Delta\left(\frac{I_t}{k_t} - \delta\right)}{\Delta r} = \frac{\Delta\left(\frac{I_t}{k_t} - \delta\right)}{\Delta(x+r)} \frac{\Delta(x+r)}{\Delta r} \sim \left(1 + \frac{\Delta x}{\Delta r}\right) \times \frac{1}{\phi} \times \frac{\text{Dur}}{x \times \text{Dur} + 1}. \tag{8}$$

Consider first the case where changes in cost of capital are passed one-to-one into discount rates $\left(\text{i.e., } \frac{\Delta(x+r)}{\Delta r} = 1\right)$. In this case, a positive discount rate wedge ($x > 0$) lowers the impact of any discount rate variation through the adjustment introduced in Proposition 2. Indeed, a higher wedge causes a shorter cash flow duration, which lower the sensitivity to discount rate movements. We refer to this as the duration channel.

---

[16] The assumption $\phi = 10$ is based on Philippon (2009), who discusses various estimates used in the literature. In the upcoming test of Q models in Section 4.2, we find $\phi > 10$ when using Tobin's Q but $\phi < 10$ when using adjusted Q.

The second channel is related to the term $\frac{\Delta(x+r)}{\Delta r}$. This term is generally smaller than one in the data. For the cost of capital, the estimate is around 0.6, as shown in Table 9 and Section 5.2). For the cost of debt (i.e., interest rates), the estimate is around 0.3, as shown in Table 2. We refer to this diminished transmission as the stickiness channel.

Figure 7 shows the effect of the cost of capital on investment rates under different assumptions. The existence of discount rate wedges substantially dampens the effect. This happens mostly through the first of the two channels discussed above, namely the duration channel: going form a model without discount rate wedges to a model with discount rate wedges and $\frac{\Delta(x+r)}{\Delta r} = 1$ lowers the effect from -3 to -1. Further incorporating the stickiness channel lowers the number to -0.6.

4.2 Adjusted Q

Positive discount rate wedges imply that firms and financial markets use different discount rates. As such, we cannot directly use financial market data to infer discount rates and thus investment incentives of firms. This insight is important for Q theory, which measures the value of an additional unit of capital on financial markets. In the presence of discount rate wedges, one has to adjust Tobin's Q for these.

Proposition 1 shows how to adjust Tobin's Q for discount rate wedges. To calculate adjusted Q, we need to know the discount rates used by firms, the cost of capital, and the duration of cash flows. We observe the first two from conference calls and calculate the duration of cash flows using the Gordon Growth model, in which the duration of cash flows reaching equityholders is given by the earnings yield (see Appendix), combined with the assumption that debt has a duration of five years. We calculate the earnings yield by the inverse of the CAPE ratio.

Figure 8 plots adjusted Q along with Tobin's Q. The adjustment for discount rate wedges has a substantial impact, as adjusted Q is well below Tobin's Q. Adjusted Q is lower because firms put a lower value on the cash flows produced by capital than the market does (i.e., firms use higher discount rates). Adjusted Q hovers around 1 across time, as we expect from theory, and it is substantially less volatile than Tobin's Q. In addition, adjusted Q and Tobin's Q trend downwards throughout the sample, something we will address in more detail in the next section.

We test the ability of adjusted Q to explain investment in the cross-section of US stocks in Table 6. To ease comparison with previous studies, we measure Tobin's Q using data

19

on total Q from Peters and Taylor (2017) in this exercise (these are only available for US firms and until 2016). To implement the analysis for as many firms as possible, we assume that the discount rate wedge for any firm is equal to the average observed discount rate wedge in the given year in the US. The impact of this common discount rate wedge is still heterogeneous across firms because of differences in cash flow duration. To limit the number of new variables we introduce, and to put adjusted Q and Tobin's Q on a more level playing field, we proxy for duration using total Q, as explained in Appendix 7.1.

As shown in Table 6, adjusted Q performs substantially better than Tobin's Q in traditional investment regressions. Consistent with previous findings, the slope coefficient on Tobin's Q is only 0.02, which implies high adjustment costs. For instance, a net investment of 10% would cost around 25% of the value of the firm's capital stock in adjustment costs. The slope coefficient on adjusted Q, in contrast, is almost an order of magnitude larger, suggesting more reasonable adjustment costs. The implied adjustment cost of a net investment of 10% is now a more reasonable 2.5% of the capital stock. In addition to the high slope coefficients, adjusted Q also produces a higher R^2 than Tobin's Q, further emphasizing the value of adjusting Q for discount rate wedges.

4.3   Adjusted Q and "Missing Investment"

The left-hand plot in Figure 9 shows net investment by decade along with Tobin's Q. The figure reveals that net investment in recent decades has been fairly low relative to the time-series, which is surprising given the high values of Q. This divergence between investment and Q has lead to a debate about what Gutiérrez and Philippon (2017) refer to as "missing investment" (i.e., low investment despite high equity valuations and low interest rates).

Discount rate wedges help us to understand missing investment. To see this, we can start by considering the adjusted Q in Figure 8. The adjusted Q stays close to 1 throughout the sample, and trends down slightly, which means the adjusted Q would not suggest that investment should be particularly high and rising during our sample. To put this finding in perspective, the right-hand plot in Figure 9 considers a time series estimate for the long-run evolution of the adjusted Q. We calculate the adjusted Q pre-2002 by assuming that discount rates are 5 percent higher than the cost of capital. When measured this way, investment appears to be close to what the adjusted Q would suggest. We caution, however, that this analysis requires backward extrapolation of discount rate wedges over almost a century and

it relies on a slightly different measure of Q than what is normally used.[17]

To formally address missing investment, Figure 10 plots cumulative investment shortfalls (relative to the capital stock) obtained from Tobin's Q and adjusted Q. For both types of Q, we fit an investment regression in the 1990 to 2002 sample (following Gutiérrez and Philippon (2017)) and calculate investment residuals relative to the estimated parameters. The figure shows that investment was lackluster relative to Tobin's Q throughout the sample. In contrast, the residuals for adjusted Q hover around zero throughout the sample. By 2020, the difference between the two estimates is almost 20 percent of the capital stock. This implies that the cumulative investment shortfall relative to Tobin's Q is 20 percent larger than the shortfall predicted by adjusted Q. This exercise also requires backwards extrapolation of discount rate wedges, although only over a 12 year period.

The analysis above suggests that the wedge between discount rates and the cost of capital is sizable enough to account for a large part of missing investment in the 21$^{\text{st}}$ century. As such, the investment behavior of firms is consistent with standard investment models, given that they use discount rates that deviate from the cost of capital.

5   Exploring Variation in Discount Rates

The analysis above documents that firms' discount rates have important implications for our understanding of the link between investment and financial markets. In this section, we explore the drivers of discount rates across firms and time.

We take three steps. We first study which firm-level observables, apart from the financial cost of capital, can cross-sectionally explain the level of discount rates. We then show that changes in the financial cost of capital are not fully incorporated into discount rates. Finally, we analyze how market power has affected changes in discount rates since 2002.

5.1   Cross-Sectional Drivers of Discount Rates

We test a number of explanations for why firms might use discount rates that differ from the cost of capital. We broadly categorize these explanations into two categories: risk and organizational constraints.

---

[17]We measure Q using only book-to-market values of equity as we do not observe other required accounting information.

5.1.1 Risk and Uncertainty

2016-11-10, Halyard Health Inc., Steve Voskuil, CFO: *"...So that's kind of how we come to the 9% [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."*

In the above conference call from Halyard Health,[18] the CFO explains how the company uses the cost of capital as the benchmark for their discount rate and adds a wedge to reflect risk. Such behavior is common. The 2021 AFP Survey of capital budgeting practices finds that close to half of respondents increase discount rates in the face of increased uncertainty. Motivated by such evidence, we study the association between discount rates and risk.

We find a strong relationship between discount rates and risk, as shown in Table 7. In all specifications, we control for the firm's financial cost of capital, since we are interested in drivers of discount rates beyond the cost of capital. We measure risk using the implied volatility of firm equity, estimated using options written on the equity.[19] Discount rates load positively on implied volatility in columns 1 and 2. The point estimate implies that a one percent increase in implied volatility leads to a 22 basis point increase in the discount rate. This is a large magnitude given the that the panel-wise standard deviation of the implied volatility is 12%. The R^2 is around 20%, mainly driven by the implied volatility, further underscoring the importance of risk.

We find that idiosyncratic volatility is more important than systematic volatility. In column 3, we separate volatility into overall volatility and idiosyncratic volatility (relative to the market). Discount rates load positively on the idiosyncratic volatility but negatively on overall volatility (once controlling for idiosyncratic volatility). These results are consistent with Jagannathan et al. (2016) and Décaire (2021) who find that discount rates are higher for firms for which most volatility is idiosyncratic.

Why might risk lead to higher discount rates? The risk of a representative project should already be reflected in a firm's cost of capital – if the firm is riskier, investors will require a higher return. From an investor's point of view, it is therefore unclear why one would require a premium on top of the cost of capital. However, from a manager's point of view, the situation is different. The manager is often highly overexposed to the firm, as a resolution to the classical agency problem arising from separation of ownership and

---

[18]Halyard Health, formerly known as Kimberly-Clark Health Care, was a global producer of medical supplies. Most of Halyard Health is now part of the Fortune 500 company Owens & Minor Inc.

[19]We focus on options with 365 days to maturity.

control. This overexposure means that the risk-return trade-off different is different for the manager than for the investor. In particular, while idiosyncratic risk does not influence the required return of the well-diversified investor, it does influence the required return from the manager because the idiosyncratic risk is non-diversifiable to her. As such, adding a premium to discount rates could potentially lead to an increase in the manager's private utility (Jagannathan et al. 2016).

Alternatively, managers might also incorporate risk and uncertainty in discount rates as a way of simplifying complicated investment decisions. In certain investment decisions, like when to drill an oil wheel, the optimal investment decision involves complicated calculations of the option value of delaying investment (Dixit and Pindyck 2012). McDonald (2000) shows that managers often can approximate the optimal investment decision in such settings by adjusting the discount rate. In particular, they can approximate optional decision making by using higher discount rates when uncertainty is higher.[20].

Risk might also influence discount rates due to perceived mispricing of equity. Stein (1996) argues that, in the presence of mispricing, managers who maximize long-run equity prices might not want to use the financial cost of capital (expected stock returns) as their discount rate. Rather, if certain risk factors, such as market betas, are not properly incorporated in market prices, it can under certain conditions be optimal for the manager to correct for the mispricing by incorporating the risk factors in the discount rates.

Finally, managers might be disproportionately averse to the possibility that realized returns are below the cost of capital. While project with an IRR equal to the cost of capital is expected to earn the cost of capital, the realized return may be below or above that. If a project has a realized return below the cost of capital, managers might face uncomfortable questions and concerns from investors. By choosing a discount rate above the cost of capital, the managers can reduce the risk of such a scenario. While such behavior might appear inconsistent with a full-information rational equilibrium, the following quote from the Fortune 500 company Kinder Morgan is a real-life illustration for such behavior:[21]

2013-05-23, Kinder Morgan, Kim Dang, CFO: *"We do not do projects close to our cost of capital so we are not going to go – our cost of capital is 9%, we are not going to go out and do a project in 9.5% or 10% because there are just too many potential for changes in what*

---

[20]The value of the option to delay increases in uncertainty about cash flows and future discount rates (Ingersoll Jr. and Ross 1992, McDonald and Siegel 1986)

[21]Kinder Morgan is number 262 on the Fortune 500 list, has 11,000 employees, and a market cap of around $40 bn.

you expect to happen and what actually happens that can result in that project not being as good. Now it could be much better but we're not going to take the risk that we have a project come in at or below our cost of capital."

5.1.2 Organizational and Financial Constraints

Theory suggests that organizational and financial frictions can raise discount rates. For instance, firms with high leverage may forego projects with positive NPV due to debt overhang (Myers 1977), while managers in firms with many positive NPV projects may not have the available resources or expertise to pursue every project (Jagannathan and Meier 2002).

Consistent with theory, the Kinder Morgan CFO explains that financial considerations affect the discount rate in the following quote. In particular, the CFO needs to decrease leverage and does not want to issue equity (because she considers it underpriced). She therefore hopes to finance investments only out of retained earnings, which limits the amount of available capital and forces her to raise the discount rate:

2016-10-19, Kinder Morgan, Kim Dang, CFO: *"So in my mind, what we are constrained by, we do want to improve the balance sheet, and that is a goal that we have. But what we're doing is 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% IRR for projects. I fully anticipate that over time, as the CapEx comes down, and also as the balance sheet improves, that we would relax that standard. I don't know exactly what that number is going to be today, but it would be something less than the 15%. It probably won't be back at the 8% that we previously used for a hurdle rate, but we will have to make the assessment, when that time comes."*

We find that highly levered firms tend to have higher discount rates, conditional on the cost of capital, consistent with a role for financial constraints (8, column 1). Cash holdings and positive growth forecasts are associated with more investment opportunities and have been used to proxy for organizational constraints (Opler et al. 1999, Simutin 2010, Asvanunt et al. 2011, Jagannathan et al. 2016). Accordingly, we show that firms with high cash-to-assets ratios and high growth forecasts (measured by expected long-term growth from the Institutional Brokers' Estimate System) have larger discount rates, supporting the view that organizational constraints also play a role (columns 2 and 3).

5.2 Firm-level Changes in Discount Rates and the Perceived Cost of Capital

We have so far argued that risk, financial, and organizational constraints are associated with greater discount rates, even conditional on the cost of capital. An open question is how firms' discount rates move over time with the cost of capital. If the wedge between discount rates and cost of capital is constant over time, shocks to cost of capital would be dynamically incorporated into discount rates.

We find that the firm-level relationship between discount rates and the cost of capital is strong, with a slope coefficient of roughly 0.6 (Table 9). The effect is relatively stable across specifications without controls and with firm and year fixed effects. This implies that the average firm raises its discount rate by 0.6 percentage points when its perceived cost of capital changes by 1. The slope is statistically different from 0 and from 1. As such, the results imply that firms incorporate changes in the cost of capital in their discount rates, although the effect is less than the one-to-one incorporation that is often assumed in standard models.

The firm-level analysis requires that we observe both the discount rate and the perceived cost of capital in the same quarter for the same firm. This requirement lowers the number of observations. To ensure that results are robust, we additionally study the relationship between cost of capital and required return on invested capital/equity, which we also extract from conference calls. These metrics are not to be understood as discount rates, but they are likely correlated with discount rates. Consistent with this idea, we find that the required return on invested capital/equity is positively related to the cost of capital, both with and without firm and year fixed effects.

5.3 Competition and Discount Rate Wedges

As shown in Figure 5, the average discount rate wedge has increased over the last two decades as the cost of capital has decreased. Are there differences by firm type in the evolution of the wedge? What economic forces lead firms to lower discount rates along with the cost of capital?

One hypothesis emphasizes the role of product market competition. In perfectly competitive markets, all firms must earn the same return. If one firm lowers the required rate of return based on a decrease in the cost of capital, other firms also have to lower their required return in order to compete in the same product market. If firms fail to do so, they

will not be able to find positive NPV projects to invest in. Market pressures may thus force firms to lower their discount rates with the cost of capital or, at least, ensure that firms with low discount rates become relatively larger over time. In contrast, firms with high market power do not face the same pressure. These firms may keep discount rates unchanged even as the cost of capital falls (e.g., due to build-ups of organizational frictions, managerial risk aversion, or myopia) without losing market share. Under this hypothesis, firms with less market power increase discount rate wedges by less when the cost of capital falls.

To test the competition hypothesis, we divide the sample into two subgroups based on firms' market power at the beginning of our sample.[22] We estimate the average discount rate in a year separately for each group as well as the average cost of capital across all firms, in both cases controlling for firm fixed effects to isolate variation over time. We then calculate the average annual discount rate wedge for each group by subtracting the average cost of capital from the average discount rate.[23]

Figure 11 show the resulting discount rate wedges. The increase in wedges takes place largely among firms with high market power. There are upticks in both groups around the financial crisis and the Covid crisis, possibly driven by a general increase in risk in these periods. Overall, however, the data are consistent with the view that competitive pressures force firms to maintain stable discount rate wedges. This finding is consistent with Philippon (2019) who argues that increases in market power have driven down corporate investment in the last decades.

6 Conclusion

This paper presents a new dataset on firms' discount rates and perceived cost of capital. The data allow us to study how firms incorporate financial market movements into their perceived cost of capital; how firms set their discount rates based on cost of capital and a range of other factors, including risk, financial, and organizational constraints; and how firm investment comoves with discount rates. We focus on the dynamics of discount rates and firm investment, as our data allow us to study within-firm variation over 19 years.

While corporate discount rates have always played an important role in macroeconomic and financial theories, a lack of data has made it difficult to empirically evaluate the impact

---

[22]We measure market power as the average markup between 2000 and 2002 in De Loecker et al. (2020).

[23]We estimate the cost of capital using the pooled sample to ensure that the results are not driven by differences in the cost of capital across the two subgroups. Estimating the cost of capital separately for each subgroup does not influence the findings.

of discount rates. Using the new data, we show that accounting for empirically grounded discount rates affects our understanding of several economic puzzles. For instance, once we incorporate discount rates into standard models, the elasticity of investment with respect to the cost of capital is relatively low; an adjusted Q-theory explains a larger share of investment fluctuations; and low investment in the US can be partially traced to managerial choices about discount rates. These findings suggest that future research into the drivers of discount rates is a promising avenue to understand investment fluctuations.

7 Appendix

7.1 Theory

7.1.1 Proof of Proposition 1

We know from (4) that

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

To estimate Q, we must calculate $V_t(x, k_t)$. Note that $V_t(x, k_t)$ is the value of the future profits produced by capital, calculated using $x + r$ as the discount rate. If we set $x = 0$, we get the value of these profits calculated using the cost of capital as the discount rates, $V_t(1, k_t)$, which is the value of the firms in the financial markets. We can approximate both using the Gordon growth model

$$V_t(1, k_t) \sim \frac{CF_{t+1}}{r - g}$$

$$V_t(x, k_t) \sim \frac{CF_{t+1}}{x + r - g}$$

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 $V_t(x, k_t)$ as

$$V_t(x, k_t) = V_t(1, k_t)\frac{r - g}{x + r - g} = V_t(1, k_t)\frac{1}{x \times \text{Dur} + 1} \tag{9}$$

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 forthcoming).

We can then calculate Q by inserting (9) into (4) and using that

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

Alternative formulation without duration

We can replace Dur in 5 with Tobin's Q and return on equity. Under the assumption

that the firm is fully equity financed,

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

such that

$$Q_t = Q^{\mathrm{Tobin}}\frac{V_t(x, k_t)}{V_t(1, k_t)} = Q^{\mathrm{Tobin}}\frac{\mathrm{ROE}}{x \times Q^{\mathrm{Tobin}} + \mathrm{ROE}}. \tag{10}$$

In the cross-sectional implementation of adjusted Q, we use the above expression and assume a constant ROE across firms. We do so to ensure that the only additional information that is incorporated in the adjusted-Q relative to Tobin's Q is the discount rate wedge (which makes comparison of the two measures easier).

References

ABEL, A. B. AND J. C. EBERLY (1994): "A Unified Model of Investment Under Uncertainty," *American Economic Review*, 84, 1369–1384.

ASVANUNT, A., M. BROADIE, AND S. M. SUNDARESAN (2011): "Managing Corporate Liquidity: Strategies and Pricing Implications," *International Journal of Theoretical and Applied Finance*, 14, 369–406.

BACHMANN, R., R. J. CABALLERO, AND E. M. R. A. ENGEL (2013): "Aggregate Implications of Lumpy Investment: New Evidence and a DSGE Model," *American Economic Journal: Macroeconomics*, 5, 29–67.

BAKER, S. R., N. BLOOM, AND S. J. DAVIS (2016): "Measuring Economic Policy Uncertainty," *Quarterly Journal of Economics*, 131, 1593–1636.

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

BLOOM, N. (2009): "The Impact of Uncertainty Shocks," *Econometrica*, 77, 623–685.

BOND, P., A. EDMANS, AND I. GOLDSTEIN (2012): "The Real Effects of Financial Markets," *Annual Review of Financial Economics*, 4, 339–360.

BOND, S. AND J. VAN REENEN (2007): "Microeconometric Models of Investment and Employment," *Handbook of Econometrics*, 6, 4417–4498.

BRAINARD, W. C. AND J. TOBIN (1968): "Pitfalls in Financial Model Building," *American Economic Review*, 58, 99–122.

CABALLERO, R. J. AND E. M. R. A. ENGEL (1999): "Explaining Investment Dynamics in US Manufacturing: A Generalized (S, s) Approach," *Econometrica*, 67, 783–826.

CABALLERO, R. J., E. FARHI, AND P.-O. GOURINCHAS (2017): "Rents, Technical Change, and Risk Premia Accounting for Secular Trends in Interest Rates, Returns on Capital, Earning Yields, and Factor Shares," *American Economic Review*, 107, 614–20.

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.

CAMPBELL, J. Y. AND M. YOGO (2006): "Efficient Tests of Stock Return Predictability," *Journal of Financial Economics*, 81, 27–60.

CHRISTIANO, L. J., M. S. EICHENBAUM, AND C. L. EVANS (2005): "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy," *Journal of Political Economy*, 113, 1–45.

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 (forthcoming): "Rents and Intangible Capital: A Q+ Framework," *Journal of Finance*.

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 (2012): *Investment Under Uncertainty*, Princeton University Press.

EISFELDT, A. L. AND D. PAPANIKOLAOU (2013): "Organization Capital and the Cross-Section of Expected Returns," *Journal of Finance*, 68, 1365–1406.

ERICKSON, T. AND T. M. WHITED (2000): "Measurement Error and the Relationship Between Investment and Q," *Journal of Political Economy*, 108, 1027–1057.

FAMA, E. F. AND K. R. FRENCH (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.

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 (forthcoming): "Duration-Driven Returns," *Journal of Finance.*

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.

HALL, R. E. (2001): "The Stock Market and Capital Accumulation," *American Economic Review*, 91, 1185–1202.

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

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.

HOUSE, C. L. (2014): "Fixed Costs and Long-Lived Investments," *Journal of Monetary Economics*, 68, 86–100.

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.

KARABARBOUNIS, L. AND B. NEIMAN (2019): "Accounting for Factorless Income," *NBER Macroeconomics Annual 2018*, 33, 167–228.

KHAN, A. AND J. K. THOMAS (2008): "Idiosyncratic Shocks and the Role of Nonconvexities in Plant and Aggregate Investment Dynamics," *Econometrica*, 76, 395–436.

KOBY, Y. AND C. WOLF (2020): "Aggregation in Heterogeneous-Firm Models: Theory and Measurement," .

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.

LIU, E., A. MIAN, AND A. SUFI (2022): "Low Interest Rates, Market Power, and Productivity Growth," *Econometrica*, 90, 193–221.

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.

MCDONALD, R. L. AND D. SIEGEL (1986): "The Value of Waiting to Invest," *Quarterly Journal of Economics*, 101, 707–727.

MYERS, S. C. (1977): "Determinants of Corporate Borrowing," *Journal of Financial Economics*, 5, 147–175.

OPLER, T., L. PINKOWITZ, R. M. STULZ, AND R. WILLIAMSON (1999): "The Determinants and Implications of Corporate Cash Holdings," *Journal of Financial Economics*, 52, 3–46.

PÁSTOR, ĽUBOŠ. AND R. F. STAMBAUGH (1999): "Costs of Equity Capital and Model Mispricing," *Journal of Finance*, 54, 67–121.

PETERS, R. H. AND L. A. TAYLOR (2017): "Intangible Capital and the Investment-Q Relation," *Journal of Financial Economics*, 123, 251–272.

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.

———— (2019): *The Great Reversal*, Harvard University Press.

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.

ROGNLIE, M. (2019): "Comment on "Accounting for Factorless Income"," in *NBER Macroeconomics Annual 2018*, University of Chicago Press, vol. 33, 235–248.

SHARPE, S. A. AND G. A. SUAREZ (2020): "Why Isn't Business Investment More Sensitive to Interest Rates? Evidence from Surveys," *Management Science*, 67, 720–741.

SIMUTIN, M. (2010): "Excess Cash and Stock Returns," *Financial Management*, 39, 1197–1222.

STAMBAUGH, R. F. (1999): "Predictive Regressions," *Journal of Financial Economics*, 54, 375–421.

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

SUMMERS, L. H. (1981): "Taxation and Corporate Investment: A Q-Theory Approach," *Brookings Papers on Economic Activity*, 67–140.

———— (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.

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

WINBERRY, T. (2021): "Lumpy Investment, Business Cycles, and Stimulus Policy," *American Economic Review*, 111, 364–96.

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: Summary statistics

	(1)	(2)	(3)	(4)
VARIABLES	N	mean	p5	p95
Perceived cost of debt	3,929	4.56	1.75	8.40
Perceived cost of equity	257	10.5	5.32	15.5
Perceived cost of capital	1,805	8.88	6	12.2
Discount rate	2,277	15.8	8	30
Investment rate (net of depreciation)	3,922	-4.40	-37.2	13.7
Market value (million USD)	3,695	13,973	299	52,506
Return on equity	3,384	0.11	-0.033	0.26

Panel B: Representativeness

	(1)	(2)	(3)	(4)
VARIABLES	Any	Any	Any	Any
Return on equity (rank)	0.042**			
	(0.018)			
Market value (rank)		0.15***		
		(0.020)		
Book-to-market (rank)			0.014*	
			(0.0074)	
Investment rate (rank)				0.0055
				(0.0079)
Constant	3.36***	3.58***	3.63***	3.25***
	(0.44)	(0.65)	(0.56)	(0.45)
Observations	55,950	48,898	45,983	49,154
Cluster	Country	Country	Country	Country
Within R2	0.0022	0.044	0.00030	0.000048

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

Table 2
The Perceived Cost of Capital at the Country Level

This table reports results of panel regressions of the country-year level average perceived cost of capital in a country on the cost of debt (as obtained in conference calls) and the long-run expected stock return in the same country at the same time:

$$\text{Cost of capital}_t^i = \beta_0 + \beta_1 \text{Cost of debt}_t^i + \beta_2 E[r_t^{\text{Equity}} | \text{Asset prices}_t] + \varepsilon_t^i$$

where i denotes country and t denotes calendar years. Long-run expected stock returns are measured using CAPE in the US and Campbell and Thompson (2008) outside the US, as explained in the text. The sample covers 10 countries and runs from 2005 to 2020. Standard errors are double-clustered by year and country. Regressions are weighted by the number of observations on cost of capital in the country as explained in the text. The left- and right-hand side variables are measured in percentage points.

VARIABLES	(1) Cost of capital	(2) Cost of capital	(3) Cost of capital
Expected stock returns	0.22*	0.46***	0.49*
	(0.11)	(0.10)	(0.23)
Perceived cost of debt	0.38*	0.26*	0.077
	(0.17)	(0.13)	(0.073)
Constant	5.29***	3.97***	4.67*
	(1.24)	(0.90)	(2.17)
Observations	128	128	127
R-squared	0.289	0.561	0.703
FE	None	Country	Country/Year
Cluster	Country/year	Country/year	Country/year
Within R^2	0.29	0.37	0.083

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

Table 3
Discount Rates and the Cost of Capital at the Country Level

This table reports results of panel regressions of the country-year level average discount rates on the perceived cost of capital. The sample covers 10 countries and runs from 2005 to 2021. Standard errors are double-clustered by year and country. Regressions are weighted by the number of observations on discount rates in the country as explained in the text. The left- and right-hand side variables are measured in percentage points.

	(1)	(2)	(3)
		Discount rate	
Perceived cost of capital	0.83***	0.39***	0.32*
	(0.12)	(0.032)	(0.16)
Constant	8.47***	12.4***	13.0***
	(1.45)	(0.0095)	(1.50)
Observations	117	117	117
R-squared	0.132	0.523	0.606
FE	None	Country	Country/Year
Cluster	Country/year	Country/year	Country/year
Within R^2	0.13	0.046	0.021

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

Table 4
Investment and Corporate Discount Rates at the Country Level

This table reports results of panel regressions of the country-year level investment rates on the ex ante discount rates. The sample covers 10 countries and runs from 2005 to 2020. Standard errors are double-clustered by year and country. We consider net investment measured as $I_t = (\text{CAPEX}^i_{t+1} - \text{Depreciation}^i_{t+1})/\text{PPEN}^i_t$, excluding firms in the financial sector. Right hand side variables are all measured at time t, as detailed in the text. Regressions are weighted by the number of observations on discount rates in the country as explained in the text. Investment rates, discount rates, and the cost of capital are measured in percentage points. Fin. cost of capital is the financial cost of capital estimated using the cost of debt and expected stock returns.

VARIABLES	(1) NetInvest	(2) NetInvest	(3) NetInvest	(4) NetInvest	(5) NetInvest	(6) NetInvest
Discount rate	-0.26**	-0.27**	-0.33**	-0.29**	-0.34**	-0.21**
	(0.092)	(0.12)	(0.14)	(0.11)	(0.11)	(0.067)
Fin. cost of capital			1.32**	-1.61		
			(0.53)	(0.95)		
Tobin's Q					-2.15**	3.68***
					(0.74)	(0.86)
Observations	111	111	111	111	111	111
R-squared	0.082	0.817	0.180	0.832	0.176	0.891
FE	Country	Country/year	Country	Country/year	Country	Country/year
Cluster	Country/year	Country/year	Country/year	Country/year	Country/year	Country/year
Within R^2	0.027	0.12	0.13	0.19	0.13	0.48

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

Table 5
Investment and Corporate Discount Rates: Firm-Level Evidence

This table reports results of panel regressions of the firm-level investment rate on discount rates. We consider net investment measured as $I_t = (\text{CAPEX}_{t+1}^i - \text{Depreciation}_{t+1}^i)/\text{PPEN}_t^i$. 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.

VARIABLES	(1) NI	(2) NI	(3) NI	(4) NI	(5) NI	(6) NI
Discount rate	-0.86***	-0.79***	-0.91***	-0.88***	-0.98***	-0.93**
	(0.30)	(0.26)	(0.26)	(0.26)	(0.31)	(0.34)
Fin. cost of Capital			0.21	0.12	0.56	0.55
			(0.33)	(0.34)	(0.36)	(0.44)
ROE					0.073	0.072
					(0.092)	(0.089)
Market cap					-2.41	-1.58
					(1.48)	(2.39)
Tobin's Q					2.00***	1.87**
					(0.54)	(0.67)
Observations	928	928	834	834	586	586
R-squared	0.799	0.819	0.804	0.823	0.851	0.864
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	0.037	0.033	0.044	0.041	0.094	0.088

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

Table 6
Tobin's Q versus Adjusted Q

This table reports results of panel regressions of the firm-level investment rate on Tobin's Q and adjusted Q. We measure Tobin's Q as Total Q using data from Peters and Taylor (2017). We consider net investment measured as $I = (\text{CAPEX}_{t+1}^i - \text{Depreciation}_{t+1}^i)/\text{PPEN}_t^i$. Right hand side variables are all measured at time t, as detailed in the text. Sample is 2002 to 2016.

	Net Investment					
Adjusted Q	22.5***		20.2***		17.2***	15.0***
	(1.41)		(1.31)		(1.42)	(1.26)
Tobin's Q		2.27***		2.09***	1.24***	1.21***
		(0.20)		(0.15)	(0.18)	(0.17)
Constant	-20.5***	-11.9***	-19.2***	-11.6***	-19.3***	-18.0***
	(0.91)	(0.69)	(0.74)	(0.21)	(0.89)	(0.66)
Observations	58,935	69,840	58,935	69,840	58,581	58,581
R-squared	0.526	0.491	0.531	0.498	0.529	0.533
FE	Firm	Firm	Firm/year	Firm/year	Firm	Firm/year
Cluster	Firm/year	Firm/year	Firm/year	Firm/year	Firm/year	Firm/year
Within R^2	0.041	0.027	0.030	0.022	0.045	0.034

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

Table 7
Discount Rates and Firm-Level Risk

This table reports results of regressions of firm-level discount rates on measures of firm-level riskiness. Option-implied volatility is the at-the-money implied volatility on options written on the firm's equity as measured at time t. Realized volatility is the realized volatility on the firms equity over the past 5 years. Realized idiosyncratic volatility is the realized volatility on the firms equity over the last five years measured in excess of the part explained by exposure to the market portfolio. The regressions include the financial cost of capital on the right hand side, which is suppressed for simplicity. All volatilities are annualized. The left- and right-hand side variables are measured in percentage points. Sample is 2002 to 2021. Standard errors are double-clustered by firm and year.

VARIABLES	(1) Discount rate	(2) Discount rate	(3) Discount rate
Option-implied volatility	0.18***	0.22***	0.22***
	(0.024)	(0.025)	(0.042)
Realized volatility			-0.20**
			(0.078)
Realized idiosyncratic vol.			0.21**
			(0.081)
Observations	989	989	871
R-squared	0.176	0.250	0.265
FE	None	Year	Year
Cluster	Firm/year	Firm/year	Firm/year

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

Table 8
Discount Rates and Organizational Constraints

This table reports results of panel regressions of discount rates on measures of organizational constraints. Leverage and cash-to-assets are measured using Compustat data. Expected growth is the long-run expected growth rate from IBES data. The regressions include the financial cost of capital on the right hand side, which is suppressed for simplicity. The left- and right-hand side variables are measured in percentage points. Sample is 2002 to 2021. Standard errors are double-clustered by firm and year.

	(1)	(2)	(3)
VARIABLES	Discount rate	Discount rate	Discount rate
Leverage	0.067***		
	(0.020)		
Cash-to-assets		0.035**	
		(0.016)	
Expected growth			0.037***
			(0.0096)
Observations	1,728	1,394	793
R-squared	0.048	0.019	0.030
FE	None	None	None
Cluster	Firm/year	Firm/year	Firm/year

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

Table 9

Dynamic Updating of Discount Rates from Changes in Cost of Capital

This table reports results of panel regressions of discount rates on cost of capital from the same firm. Regressions in column (1) to (3) use our baseline measure of discount rates as the dependent variable. The regressions in (4) to (6) uses the required return on equity/invested capital as the dependent variable. Standard errors are double-clustered by firm and year. The left- and right-hand side variables are measured in percentage points. Sample is 2002 to 2021.

	(1)	(2)	(3)	(4)	(5)	(6)
	Discount rate			Required return on equity/invested capital		
Perceived cost of capital	0.72***	0.61***	0.56***	0.67***	0.54*	0.50*
	(0.11)	(0.16)	(0.13)	(0.16)	(0.27)	(0.25)
Constant	5.70***	6.44***	6.89***	6.58***	7.35***	7.69***
	(1.02)	(1.42)	(1.20)	(1.38)	(2.23)	(2.12)
Observations	266	142	136	263	163	153
Within R^2	0.19	0.68	0.52	0.12	0.12	0.064
FE	None	Firm	Firm/year	None	Firm	Firm/year
Cluster	Firm/year	Firm/year	Firm/year	Firm/year	Firm/year	Firm/year

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Figure 1
Histograms of Cost of Capital and Hurdle Rates

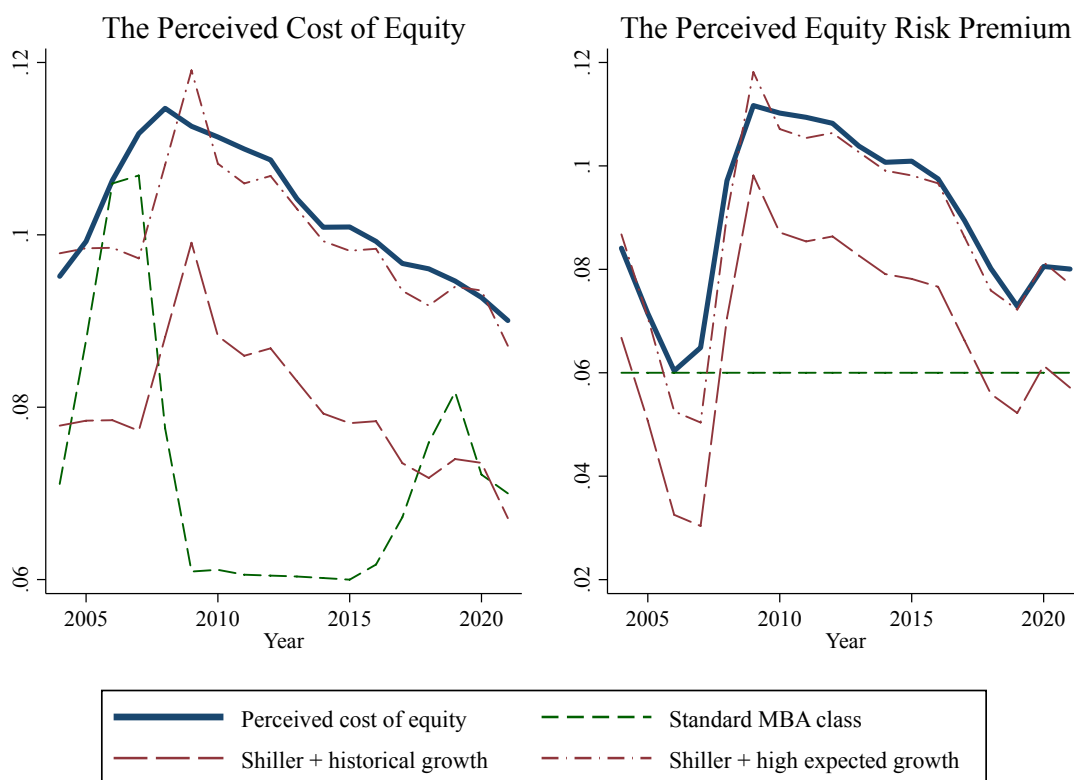This figure plots histograms for the perceived cost of capital and hurdle rates.
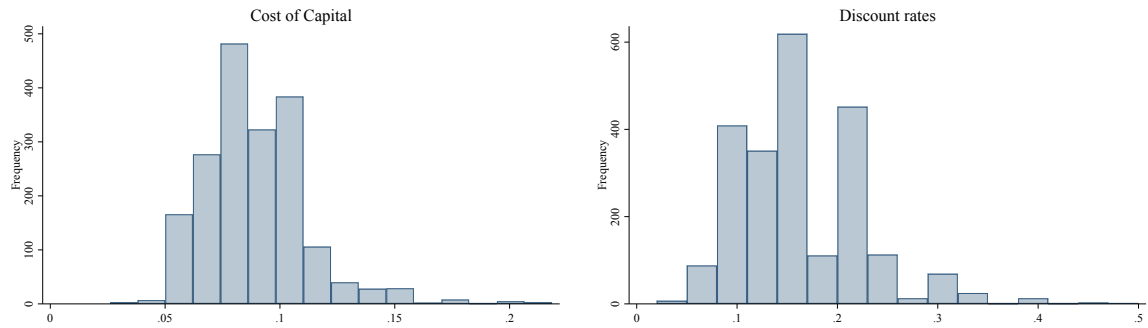
Figure 2
The Time Series of Corporate Discount Rates

This figure plots the average discount rate, perceived cost of capital, and perceived cost of debt for different years in the US.
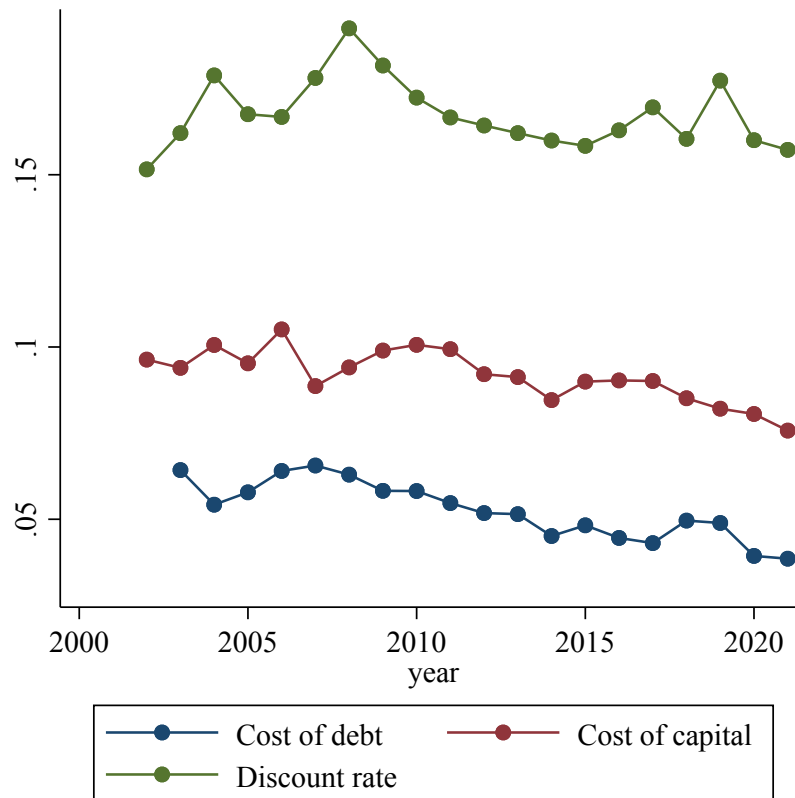
Figure 3
The Perceived Cost of Equity

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-level panel including firm fixed effects. The figure plots three-year moving averages. The "standard MBA class" measure is calculated as the risk-free rate plus the long-run market risk premium of 6%, as in the example by Cochrane (2011). The measure 'Shiller + historical growth" is the earnings yield from CAPE + a nominal growth rate of 4%. The measure 'Shiller + high expected growth" is the earnings yield from CAPE + a nominal growth rate of 6%. 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.
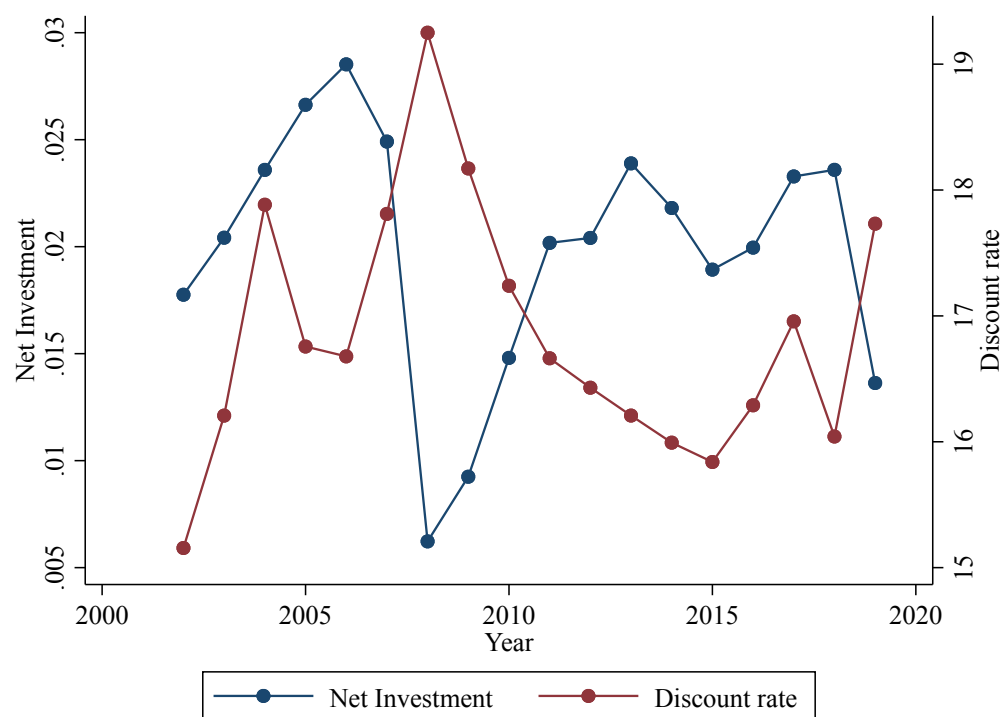
Figure 5
The Discount Rate Wedge

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.
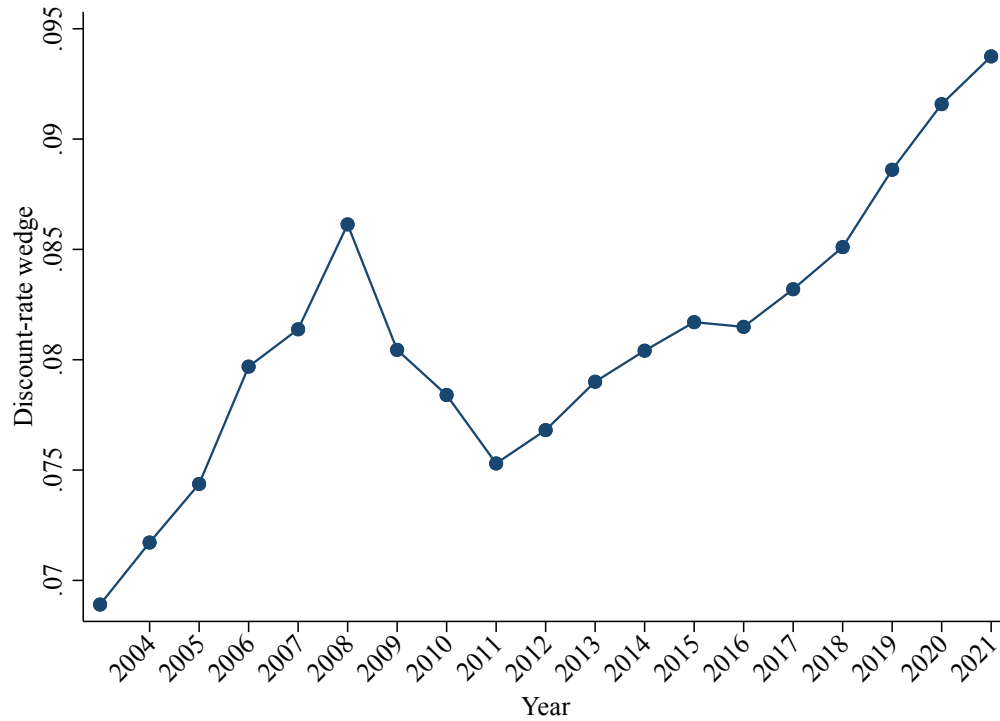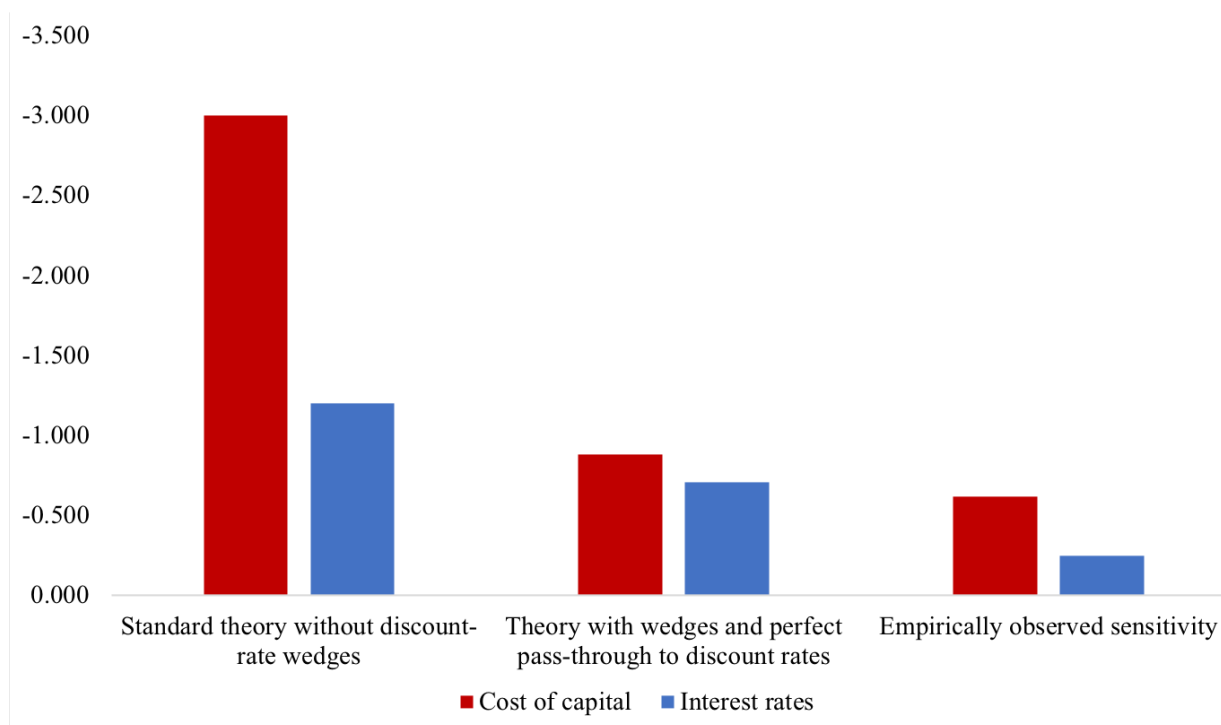
Figure 6
Discount Rates and Investment in the US

This figure the time series of discount rates and net investment in the US. Investment is lead by one year relative to hurdle rates. We measure net investment in the BEA Tables.
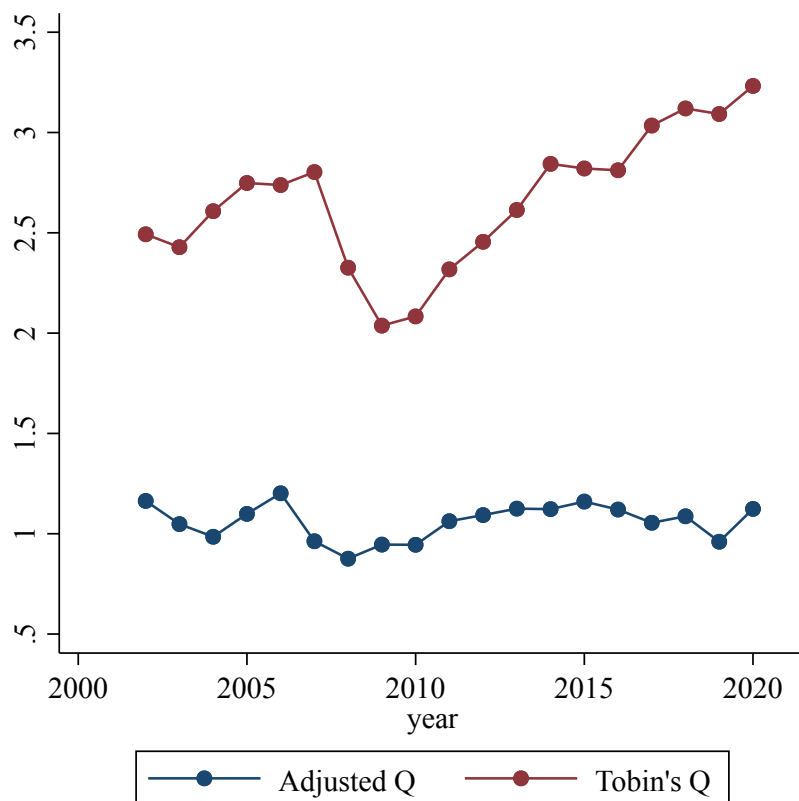
Figure 7
The Effect on Investment With and Without Discount Rate Wedges

This figure plots the effect on investment of changes in the cost of capital and cost of debt (interest rates). The leftmost bar shows the effect in a standard model without discount rate wedges. The middle bar shows the effect in our model with discount rate wedges and perfect pass-through of the cost of capital to discount rates (see text for details). The right figure shows the effect obtained by multiplying the empirically observed investment effect with the empirically observed pass-through of changes in the cost of capital to discount rates.
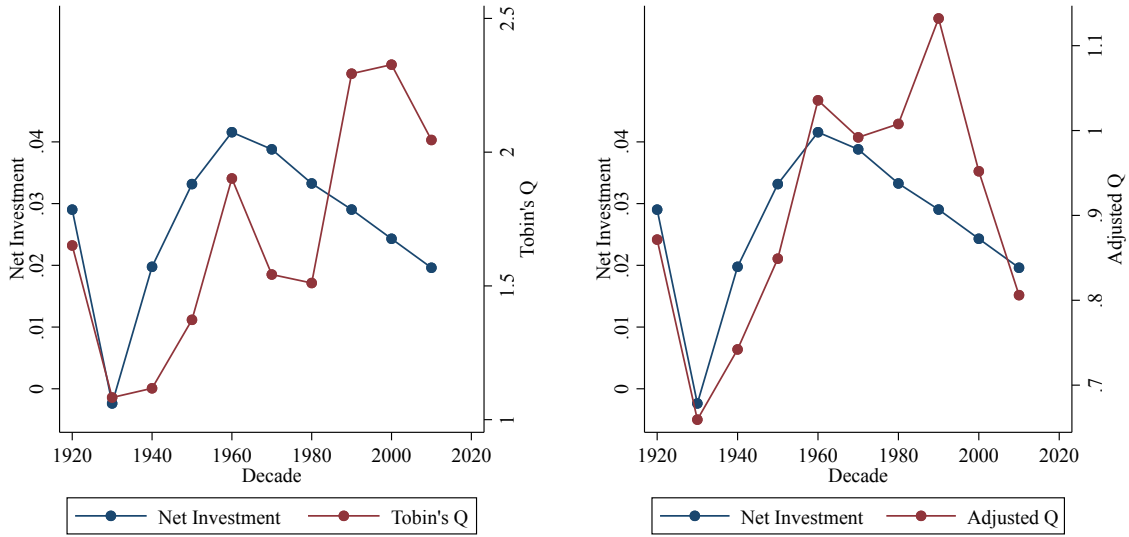
Figure 8

Figure 8
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 (forthcoming). 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.


52

Figure 9
Adjusted Q and Missing Investment

This figure plots Tobin's Q and adjusted Q by decade along with the net investment ratio by decade. The figure to the left considers Tobin's Q; the figure to the right considers adjusted Q. Adjusted Q is calculated by accounting for the wedge between discount rates and the cost of capital, as explained in the text. The figures assume that discount rates are 5% higher than the cost of capital in the pre-2002 sample. We measure Q using book to market value of equity to maximize sample length. The investment measure is aggregate investment, including intangibles, from BEA. The sample is the United States.
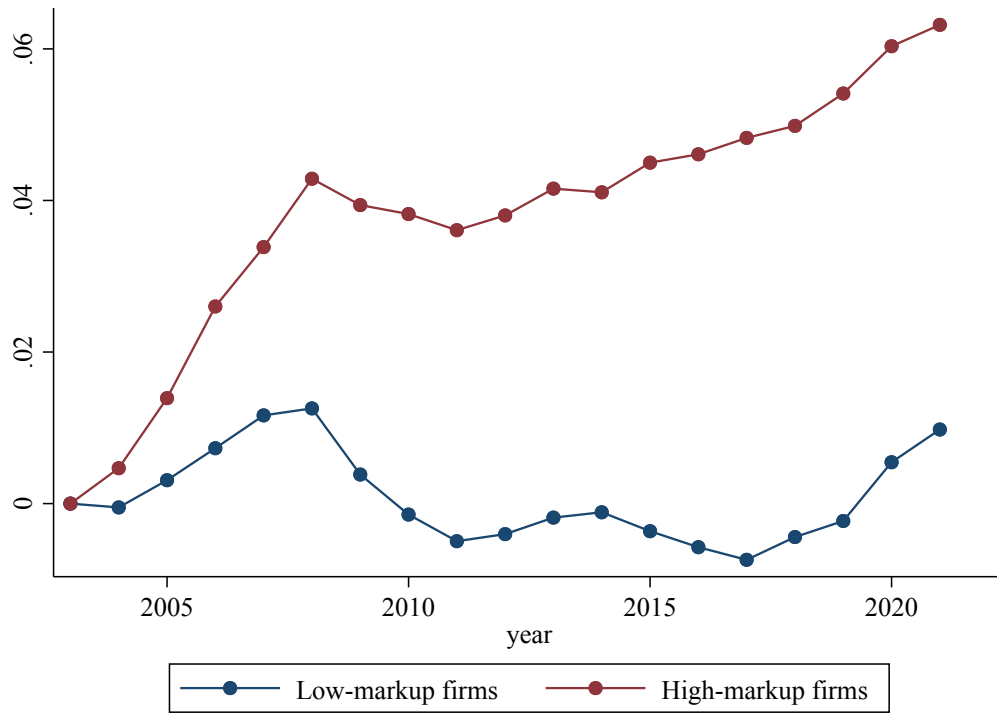
Figure 10
Cumulative Investment Residuals

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 (forthcoming). 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 fit investment on Q models using the 1990-2002 sample and calculate cumulative residuals with respect to these (see text for details). We assume the discount rate wedge is 5% in the 1990-2002 sample. The investment is aggregate investment, including intangibles, from BEA. The sample is the United States.

Investment Residuals
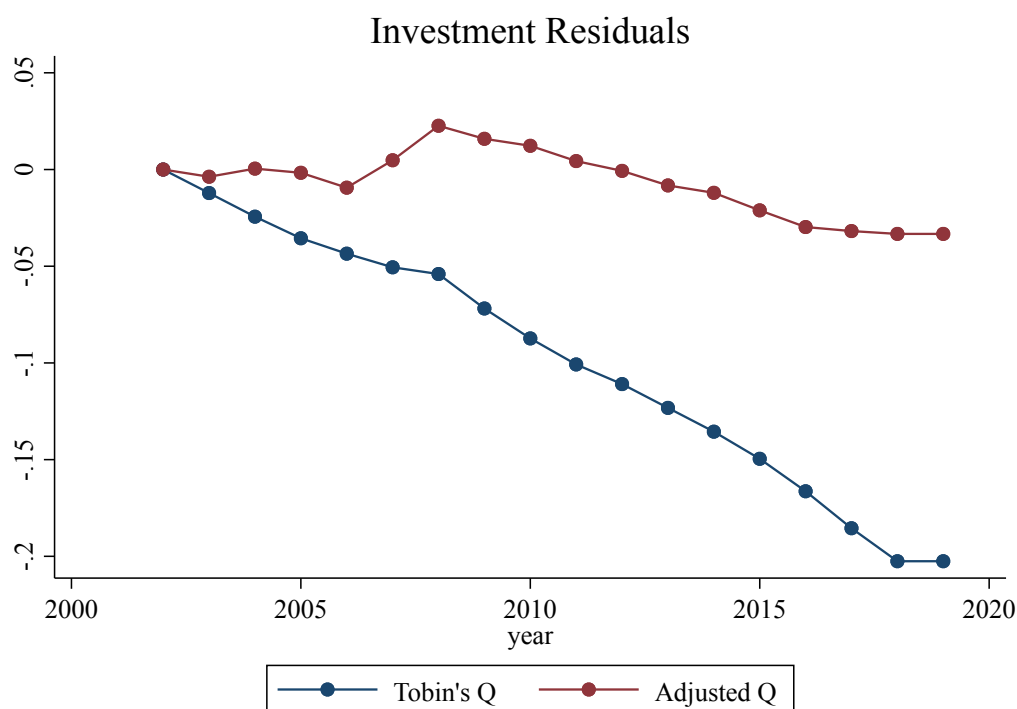
Figure 11

Market Power and Discount Rate Wedges

This figure plots the discount rate wedge 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 including firm-fixed effects. Based on these discount rates, we calculate discount rate wedges relative to the average cost of capital. We smooth the resulting time-series for discount rate wedges over three years and normalize both series to start at 0 in 2004. Markups are measured using the baseline measure in De Loecker et al. (2020).

Figure 12
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 hurdle rates (right). 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 hurdle rates and cost of capital are constant.