# Corporate Discount Rates

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# Introduction


**Stylized view in economics**

- Firms' required returns to investment, known as **discount rates**, determined by cost of capital (COC) in fin. markets
- Fin. prices directly impact investment

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**This paper**

- Measures wedges btw. discount rates and cost of capital
- Implications for relation btw. financial shocks and investment
- Since 2000: Growing wedges account for US "missing investment"

# Framework

## Textbook approach to investment

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1. Firms invest in projects for which

$$\text{expected return} > \delta,$$

   where $\delta$ = discount rate (required return)

2. $\delta$ should be the "cost of capital" of project ($r$)
   - No risk: $r$ = risk-free interest rate
   - With risk: $r$ = weighted cost of debt and equity (Modigliani and Miller 1958)

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**Textbook approach leads to a stylized view**

- $r = \delta$
- Shocks to interest rates and fin. prices have powerful effects on firms
- Dominant view in macro-finance

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**Stylized view:** $r = \delta$

**Challenges to stylized view**

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1. $r$ unobserved and difficult to estimate (Fama and French 1997):

$$r^{\text{perceived}} = r + \upsilon$$

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**Implications for stylized view and investment?**

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**Plan today**

1. Measurement of $r^{\text{perceived}}$ and $\delta$
2. Facts about $r^{\text{perceived}}$, $\delta$, and $\kappa$
3. Implications for investment
4. Determinants of $\kappa$

# Data from Corporate Conference Calls

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**Example** Nasdaq 100 and S&P 500 firm Intuit, Q1-2014:

*"We continued to take a disciplined approach to capital management, investing in opportunities that yield 15%-plus. Our weighted average cost of capital is about 9 or 9.5%. Our IRR hurdle is a 15% rate of return."*

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- Perceived cost of capital: **9.25%**
- Discount rate: **15%**
- In practical usage, hurdle = minimum required IRR = discount rate (Jagannathan et al. 2017)

# Constructing the Dataset

Approach

- Access all call transcripts on Thomson One for 2002-2021 (Frankel et al. 1999, Hassan et al. 2019)
- Identify paragraphs containing at least 1 of 20 keywords, 74k in total
- Manually enter relevant figures from all paragraphs with RA team

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  - 5-6 undergraduates UChicago
  - Training sessions and weekly meetings
  - Most cases done twice, outliers checked by authors

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High bar on terminology

- Required, realized, or expected returns? $\Rightarrow$ Collect all three separately
- Unrelated or hypothetical returns? $\Rightarrow$ Only record explicit managerial statements about investment rules
- Multiple discount rates? $\Rightarrow$ Record most reprsentative for the firm

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Repeated, high-stakes interactions

Verify: Cost of debt accurate, discount rates predict investment, discount rates predict future returns

# Features of the New Dataset

2,500 listed firms, 20 countries

- Many large firms, e.g., AT&T, Exxon, Home Depot, Intel, JPMorgan, Nestle, UnitedHealth
- Representative, except larger firms
- Included firms account for 50% of aggr. investment since 2000
- No evidence that firms experience unusual shocks when included
- Data under costofcapital.org

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Observe firm names, match real outcomes

Allows for dynamic analyses within firms (unbalanced panel 2002-21)

# Firms Included in the Sample

Skewed towards large firms

- $\sim$ 3% unconditional probability of being in sample
- $\sim$ 50% probability of inclusion for top 100 firms

Characteristics of included firms in cross-sectional percentiles

| | Discount rates | | | Perceived cost of capital | | |
|---|---|---|---|---|---|---|
| | mean | min | max | mean | min | max |
| Market value | 83.1 | 3.0 | 100.0 | 79.4 | 8.5 | 100.0 |
| Return on equity | 59.8 | 0.8 | 100.0 | 58.3 | 0.2 | 100.0 |
| Book-to-market | 49.4 | 0.2 | 100.0 | 47.3 | 0.2 | 100.0 |
| Investment rate | 53.6 | 0.3 | 100.0 | 54.0 | 1.4 | 100.0 |
| Physical capital to assets | 59.0 | 2.2 | 100.0 | 59.7 | 2.4 | 100.0 |
| Z-score (bankruptcy risk) | 47.6 | 0.8 | 99.0 | 48.8 | 2.3 | 99.0 |
| Financial constraints | 20.5 | 0.0 | 100.0 | 23.0 | 0.0 | 90.7 |
| Leverage | 60.4 | 1.2 | 100.0 | 59.3 | 0.5 | 100.0 |

Average percentile relative to all firms in Compustat in same year and country

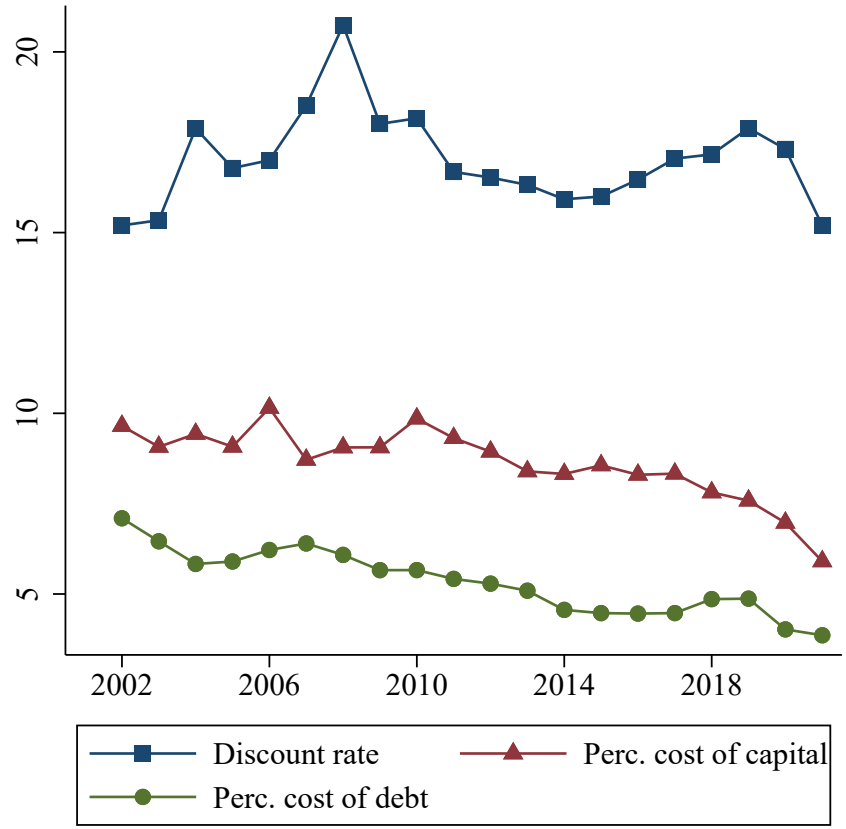
# Within-Firm Timing of Inclusion

Little evidence that firms experience shocks when included

| | Discount rate included | | Perc. COC included | |
|---|---|---|---|---|
| Z-score (bankruptcy risk) | 0.00081 | | 0.00047 | |
| | (0.0018) | | (0.0015) | |
| Return on equity | | 0.00096 | | 0.0011 |
| | | (0.0013) | | (0.0012) |
| Book-to-market | | 0.00046 | | 0.0013 |
| | | (0.0018) | | (0.0014) |
| Investment rate | | -0.0016 | | 0.00043 |
| | | (0.0012) | | (0.0011) |
| Financial constraints | | 0.0016 | | 0.0037 |
| | | (0.0027) | | (0.0039) |
| Leverage | | -0.00091 | | 0.00066 |
| | | (0.0023) | | (0.0020) |
| Observations | 228,501 | 235,329 | 228,501 | 235,329 |
| FE | Firm/year | Firm/year | Firm/year | Firm/year |
| Within $R^2$ | 2.6e-06 | 0.000020 | 9.1e-07 | 0.000036 |

Regressors in percentile ranks relative to all firms in Compustat in same year and country

# Raw Averages for US Firms




High discount rates consistent with previous surveys (Poterba and Summers 1995; Graham and Harvey 2001; Jagannathan et al. 2016)

New dataset allows us to test comovement within firms and link to investment

# Levels of Discount Rates

Puzzle in literature: high level of reported discount rates

Conference calls provide context

- Many discount rates do not account for all overhead
- Discount rates accounting for overhead are lower

| | | |
|---|---|---|
| 1 | Discount rate (mean of full sample) | 15.7 |
| 2 | Discount rate (mean of observations accounting for all overhead) | 11.4 |
| 3 | Return on invested capital (Compustat) | 13.5 |
| 4 | Total overhead over invested capital (Compustat) | 30.7 |
| 5 | Perceived cost of capital (mean of full sample) | 8.4 |

Today: focus on within-firm analyses, where levels are largely irrelevant

We control for levels when relevant

# COC, Discount Rates, and Time-Varying Wedges

# Time Variation: Financial COC → Perceived COC

| | (1) | (2) | (3) |
|---|---|---|---|
| | Perceived $CoC_t$ | | |
| Sample | U.S. only | | Global |
| Country-level earnings $yield_t$ | 0.51*** | | |
| | (0.11) | | |
| Long-term interest $rate_t$ | 0.27*** | | |
| | (0.079) | | |
| Observations | 1,543 | 1,543 | 2,625 |
| FE | None | Firm | Firm |
| $R^2$ | 0.050 | 0.88 | 0.88 |

- U.S. earnings yield = 1/CAPE
- Outside U.S.: constructed similarly
- Long-term interest rate = rate on long-term government debt

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| | (1) | (2) | (3) |
|---|---|---|---|
| | Perceived $CoC_t$ | | |
| Sample | U.S. only | | Global |
| Country-level earnings $yield_t$ | 0.51*** | 0.58*** | 0.50*** |
| | (0.11) | (0.20) | (0.12) |
| Long-term interest $rate_t$ | 0.27*** | 0.31*** | 0.25*** |
| | (0.079) | (0.063) | (0.039) |
| Observations | 1,543 | 1,543 | 2,625 |
| FE | None | Firm | Firm |
| $R^2$ | 0.050 | 0.88 | 0.88 |

- U.S. earnings yield = 1/CAPE
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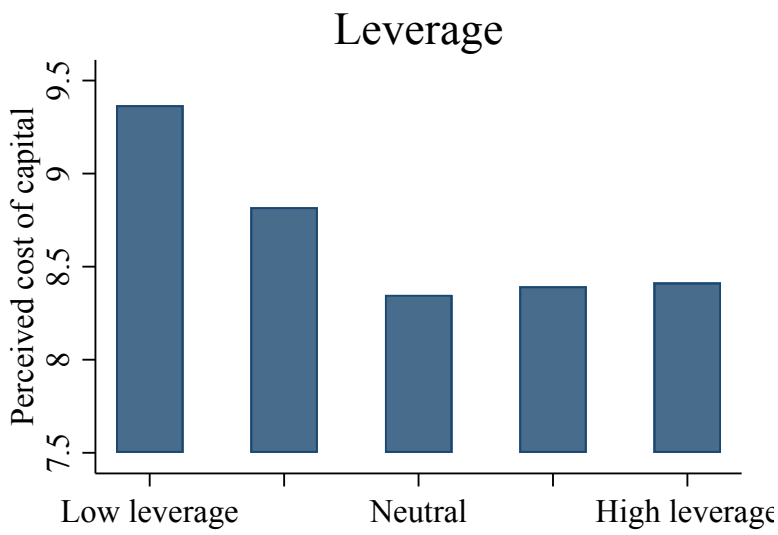
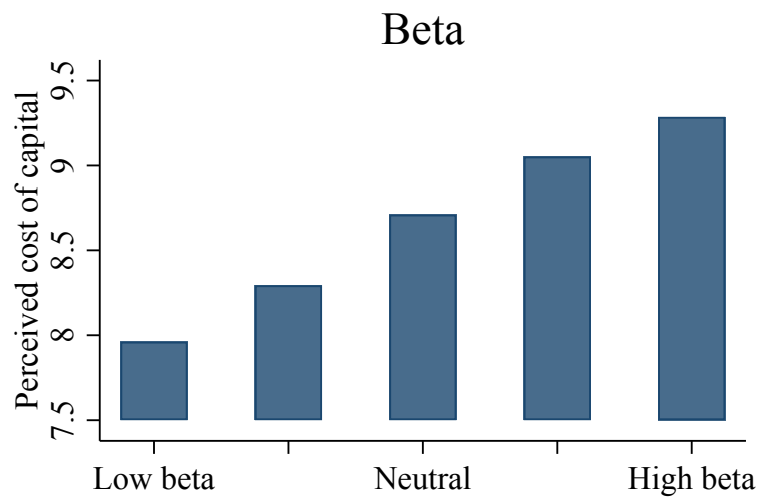
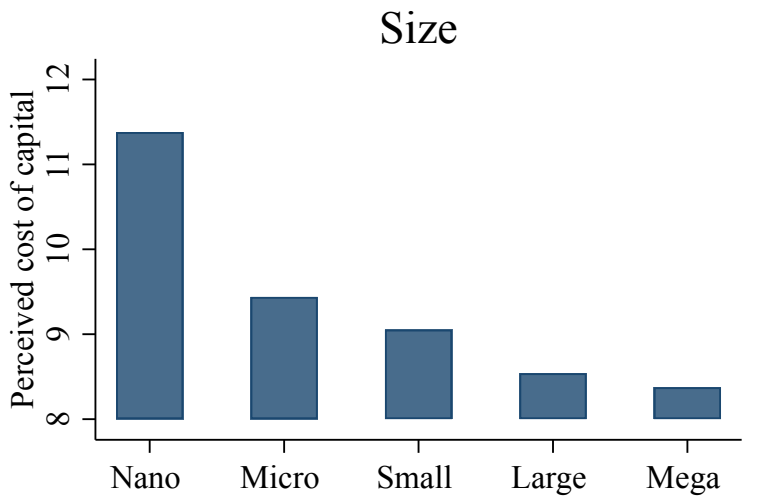
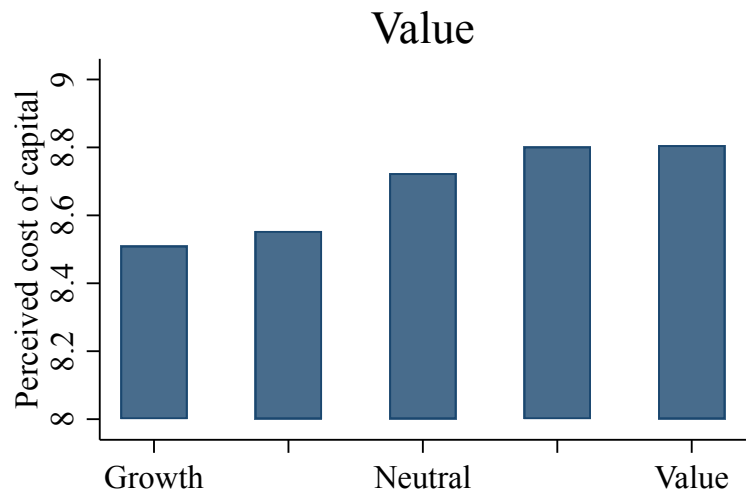
# Cross-Section: Perceived COC and Factors



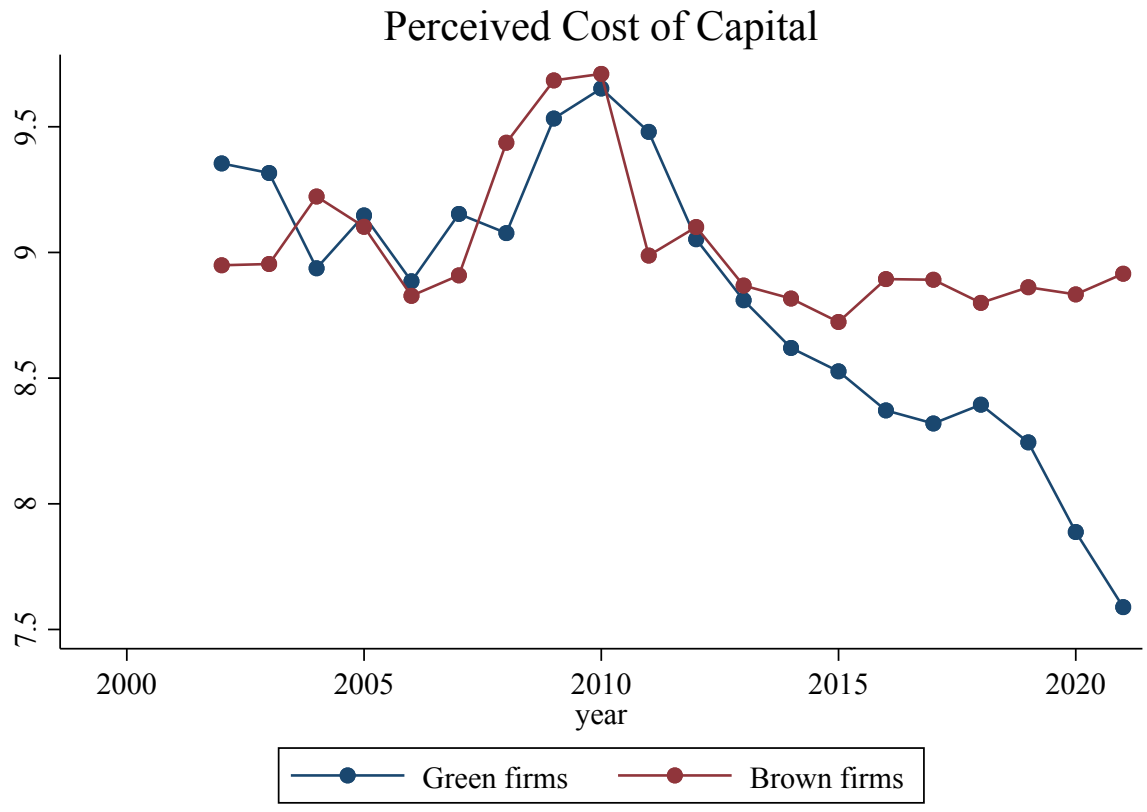




Consistent with Modigliani and Miller (1958) and Fama and French (1993)

# A Recently Incorporated Factor: Green Versus Brown




- Sort firms into green and brown using MSCI data
- Green firms perceive significantly lower CoC since 2015
- Holds conditional on Fama-French factors

# "Mistakes" in the Perceived Cost of Capital

Perceived cost of capital $\neq$ discount rates in financial markets:

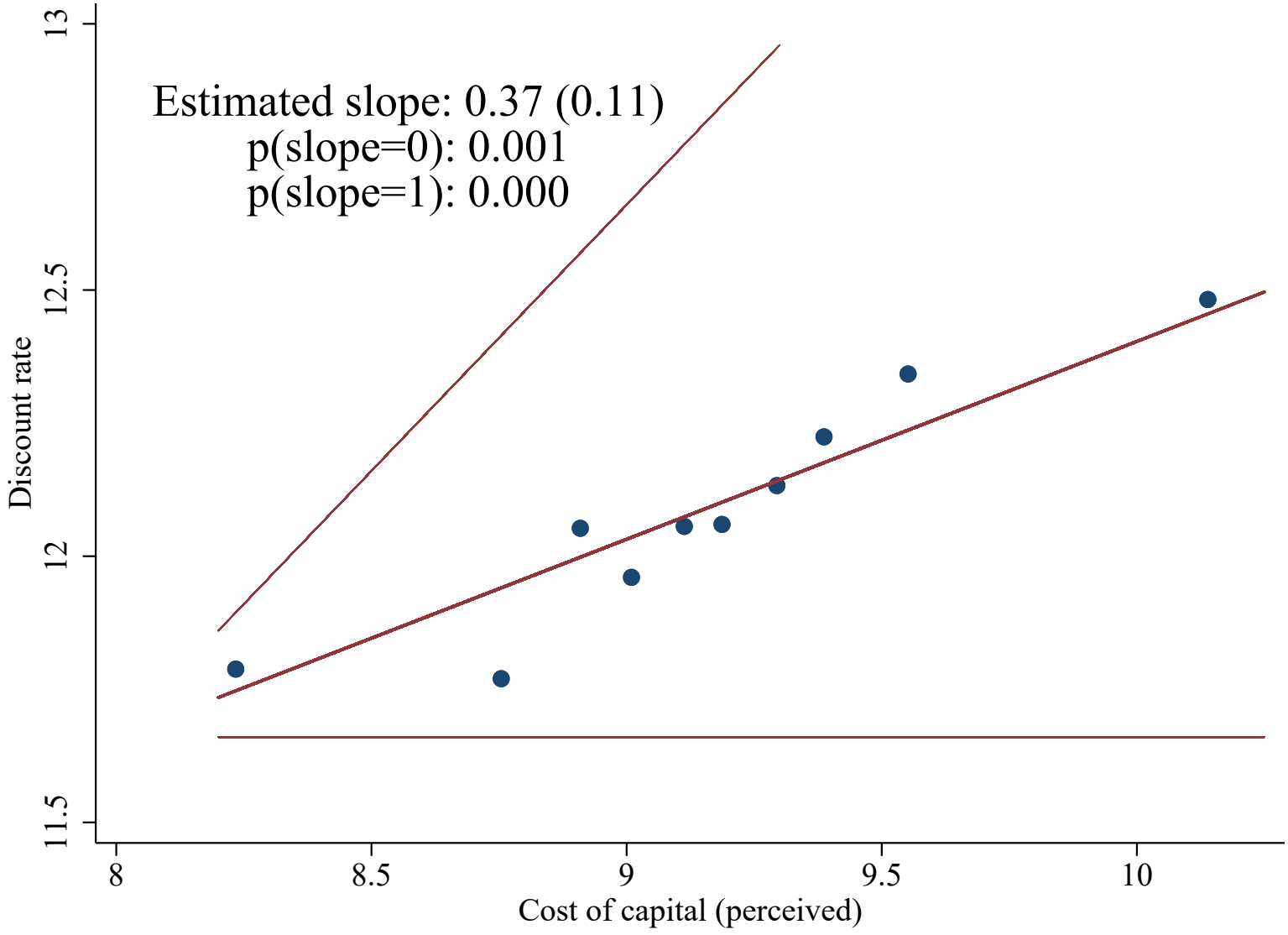
- "Excess volatility:" 70% of variation in perc. CoC not justified by future returns
- "Missing volatility:" 75% of variation in "objective" factor premia not in perc. CoC

Additional results in Gormsen and Huber (2023)

- Implications for production-based asset pricing
- Rejection of Investment CAPM by Hou et al. (2015)

# Perceived COC $\rightarrow$ Discount Rates

# Perceived COC → Discount Rates




COC ⇓ by 1 ppt. → discount rate ⇓ by 0.3 ppt (with firm and year FE)

# Perceived COC $\rightarrow$ Discount Rate

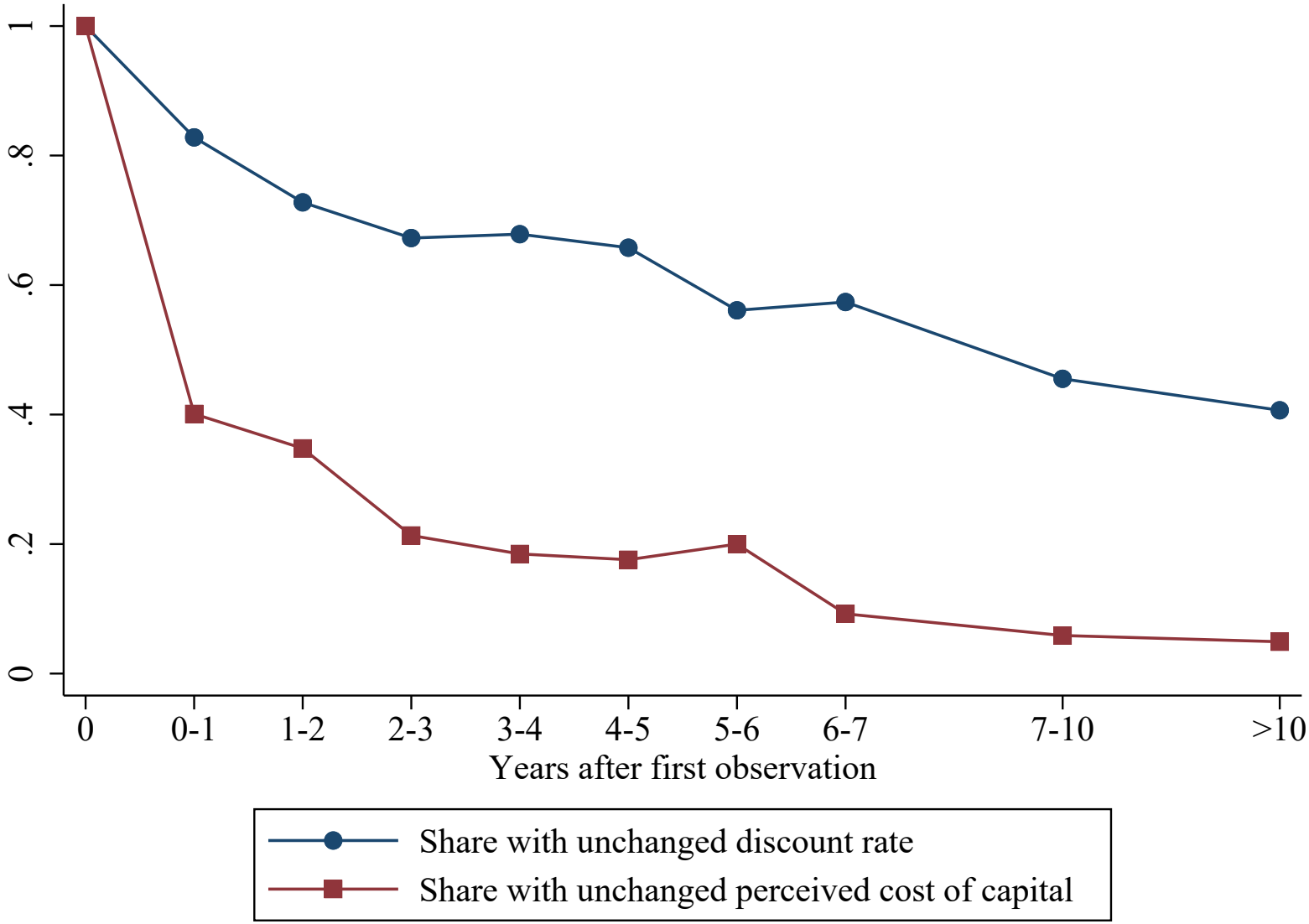
# Perceived COC → Discount Rate

| | Discount rate | | | |
|---|---|---|---|---|
| Perceived COC | 0.43*** | 0.37*** | | |
| | (0.12) | (0.11) | | |
| Perceived COC (predicted) | | | 0.36** | 0.26* |
| | | | (0.16) | (0.14) |
| Observations | 257 | 257 | 1,820 | 1,820 |
| FE | Firm | Firm/Year | Firm | Firm/Year |
| P(slope = 1) | 3.1e-06 | 6.1e-08 | 0.000084 | 3.0e-07 |
| Within $R^2$ | 0.37 | 0.20 | 0.03 | 0.0065 |

- Lasso: predict perceived COC in 1st stage, mitigates attenuation bias
- Reject stylized coefficient of 1 (and 0)
- Partial incorporation of perceived COC into discount rates

# Unchanged Discount Rates

Fraction of firms with unchanged cost of capital and discount rates over time



# Examples of Firm Behavior

**Attention to COC**

Premier, CFO, Q1-2017: *"We obviously, with changing markets, always reassess what our weighted average cost of capital is and whether that return hurdle needs to change."*

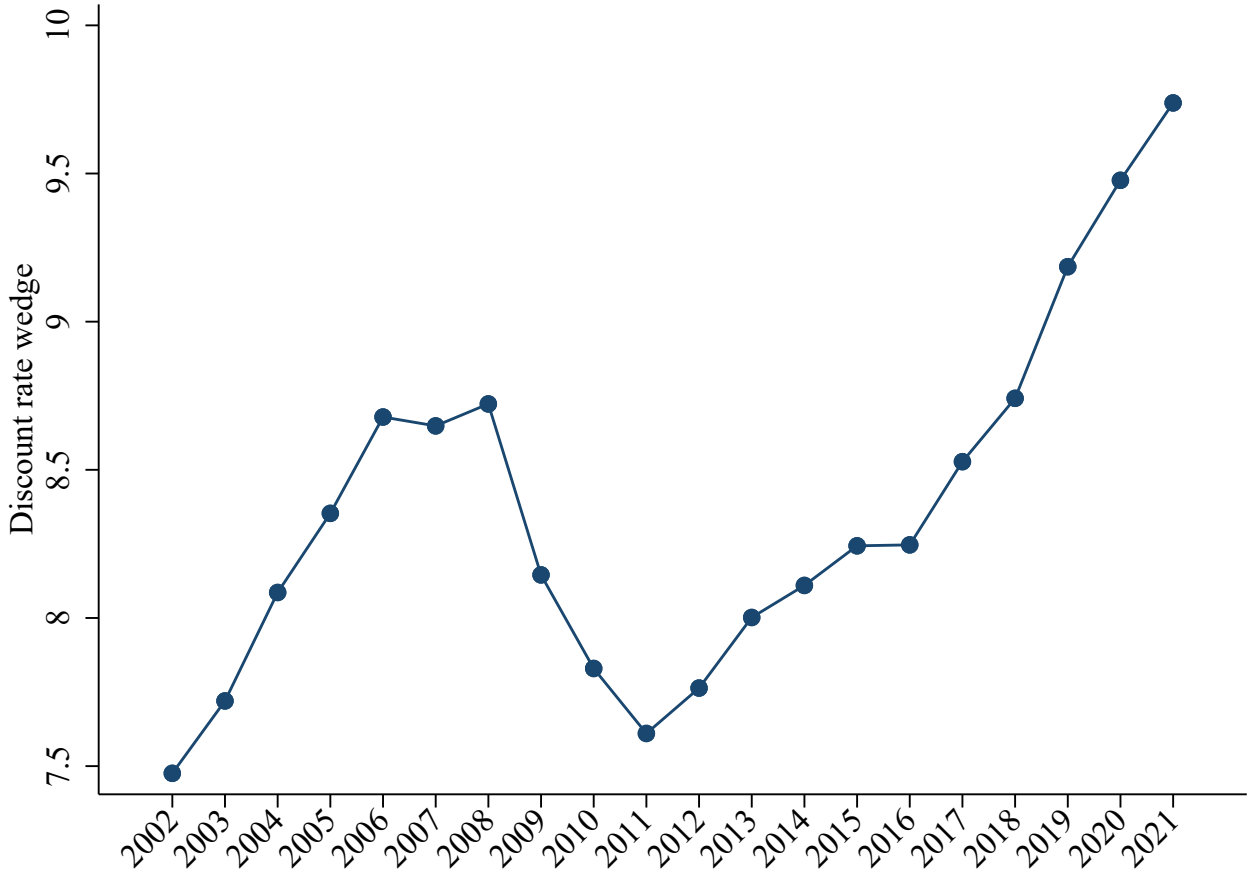
**Partial incorporation**

Spectra Energy, CFO, Q3-2014: *"We didn't lower our hurdle rates all the way down with long-term rates. We are still looking at returns of, say 10%, on average for our projects."*

**No change**

Ball Corporation, CFO, Q3-2015: *"The discount rate has been 9% for a long time. In fact, our weighted average cost of capital is less than 6% now, so people have said: why don't you lower the hurdle rate?"*

# Within-Firm, Average Discount Rate Wedge in the US

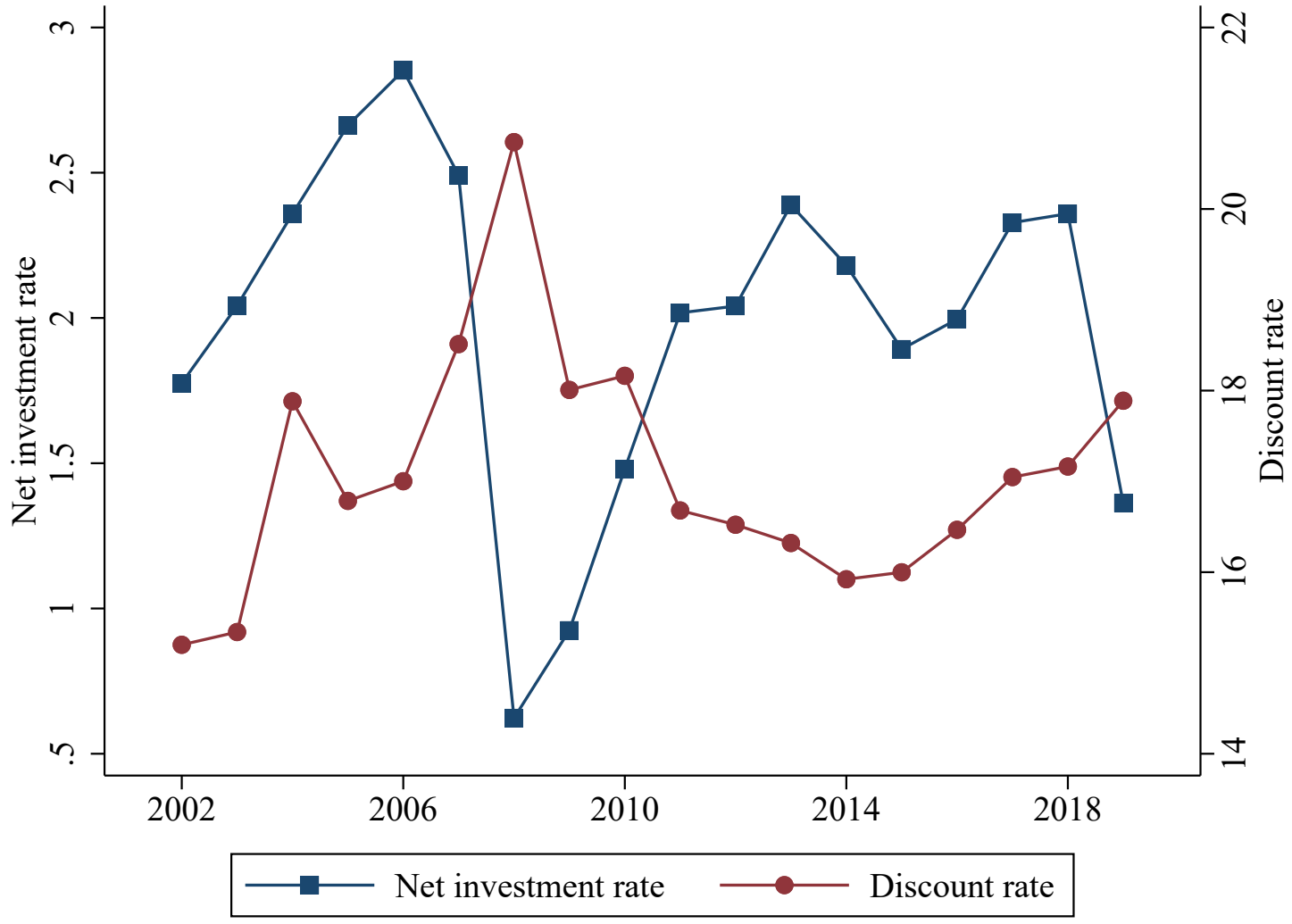



Large magnitudes: QE1 reduced corp. bond yields by 0-0.5 ppt (Krishnamurthy and Vissing-Jørgensen 2011). Natural real rate down by 1 ppt since 2002 (Bauer and Rudebusch 2020).

Post-2010 increase driven by falling COC

# Discount Rates and Investment

# Measured Discount Rates Predict Aggregate US Investment



# Discount Rate $\rightarrow$ Investment

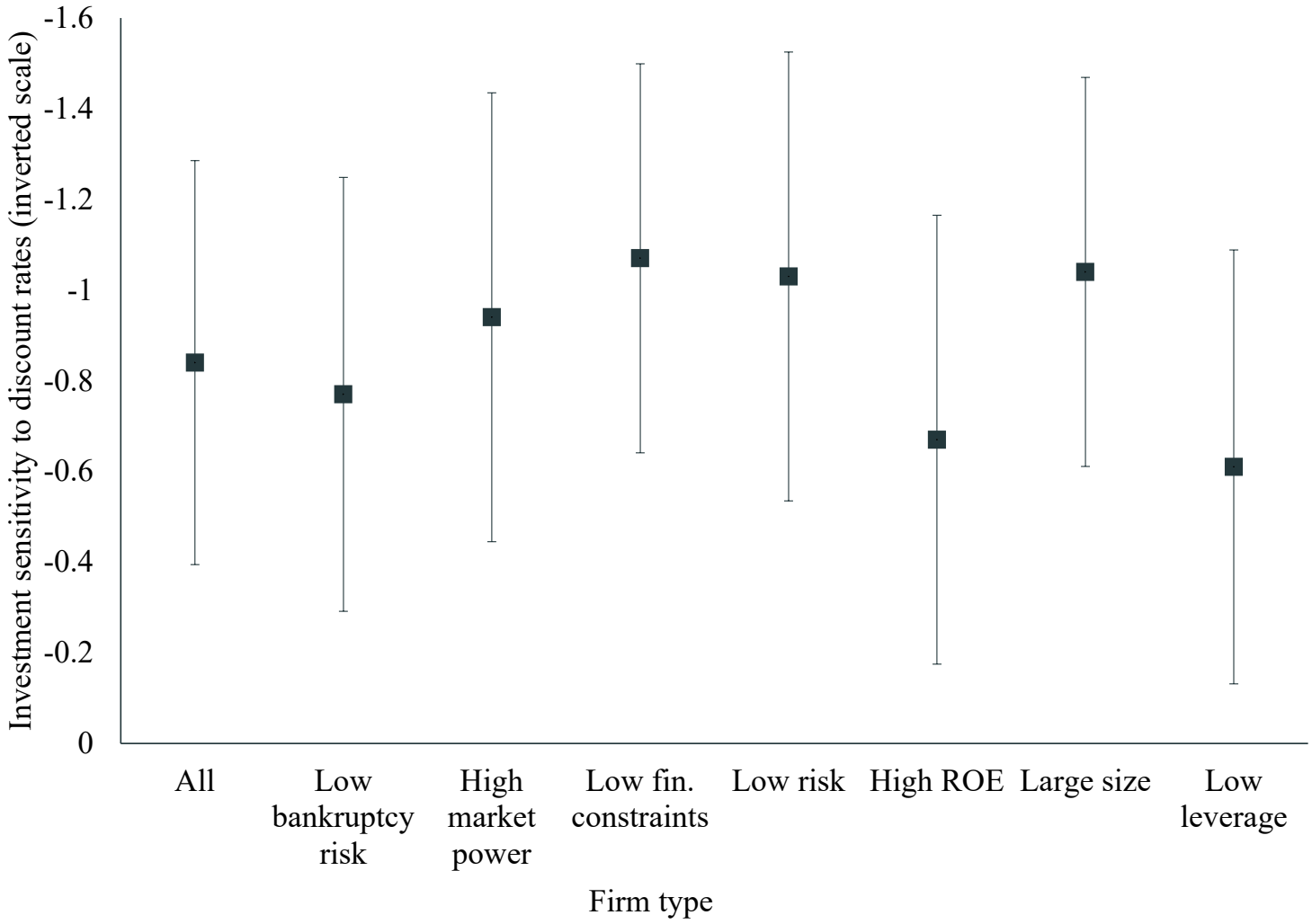
# Discount Rate → Investment

| | Net investment rate | | | |
|---|---|---|---|---|
| Discount rate | -0.93*** | -0.91*** | | -0.79*** |
| | (0.28) | (0.27) | | (0.30) |
| Discount rate wedge | | | -0.91*** | |
| | | | (0.26) | |
| Perceived COC (predicted) | | | -0.70 | 1.48 |
| | | | (1.02) | (1.56) |
| Financial COC (firm level) | | | | -0.70 |
| | | | | (1.01) |
| Tobin's Q | | | | 0.26* |
| | | | | (0.11) |
| Observations | 1,381 | 1,381 | 1,381 | 1,237 |
| FE | Firm | Firm/year | Firm/year | Firm/year |
| Within $R^2$ | 0.036 | 0.035 | 0.035 | 0.024 |

Standard Q-model (Philippon 2009) slope = -1

Measured discount rates capture component of investment demand

# Heterogeneity in Investment Regressions




- Slope in investment regressions robust accross subsamples
- Results do not appear driven by constrained or otherwise special firms

# “Missing Investment”

# "Missing Investment"

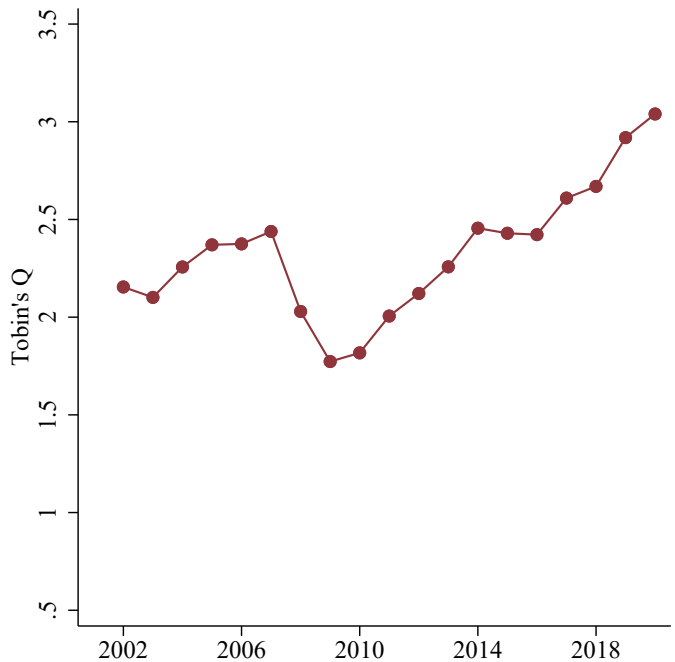
Low US investment puzzling in light of stylized view and Q-theory

- Stock/bond prices up, int. rates down $\rightarrow$ financial COC down $\rightarrow$ Tobin's Q up
- Theory: investment should rise until Tobin's Q = 1

# "Missing Investment"

Low US investment puzzling in light of stylized view and Q-theory

- Stock/bond prices up, int. rates down $\rightarrow$ financial COC down $\rightarrow$ Tobin's Q up
- Theory: investment should rise until Tobin's Q = 1
- Reality: low investment, even incl. intangibles (Crouzet et al. 2022)



# Adjusted Q

Modifying Q to allow for discount rate wedges

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Modifying Q to allow for discount rate wedges

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

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

- $r^{\text{fin.}} + \upsilon + \kappa$ = discount rate
- Tobin's Q and stylized view: $\upsilon + \kappa = 0$, i.e., firms calculate $r^{\text{fin.}}$ perfectly and set $\delta = r^{\text{fin.}}$
- $I_t$ = capital investment at time $t$
- $\Pi_t(k_t)$ = profits earned at $t$
- $\Phi(I_t, k_t, \xi)$ = adjustment costs (quadratic in net inv.)
- Profit and cost functions homogeneous of degree one

# Optimal Investment

$$\frac{I_t}{k_t} - \xi \approx \left[ Q_t^{\text{Adjusted}} - 1 \right] \times \frac{1}{\phi}$$

Adjusted Q uses observed discount rates

$$Q_t^{\text{Adjusted}} = Q_t^{\text{Tobin}} \times \frac{1}{(\upsilon + \kappa) \times \text{Dur} + 1}$$

Intuition:

- Wedges imply that firms and fin. markets use different discount rates
- The further away cash flows (high Dur), the more important wedges

# Measuring Adjusted Q

- We measure adjusted Q using new data
- Focus on $\kappa$—wedges actively chosen by firms

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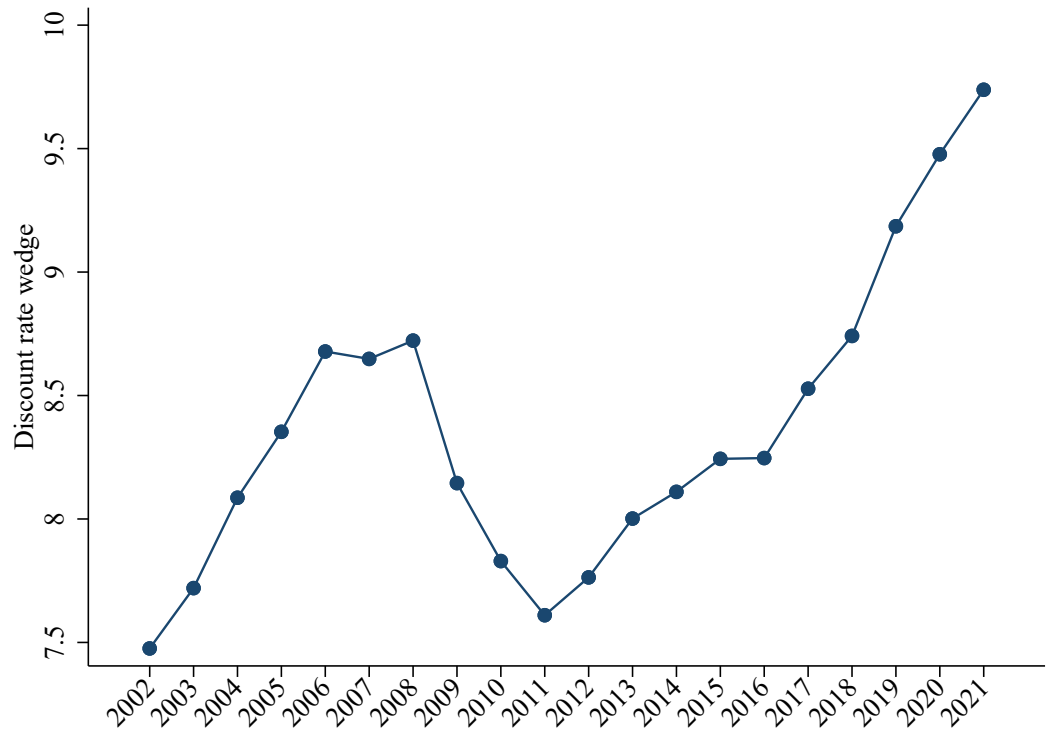
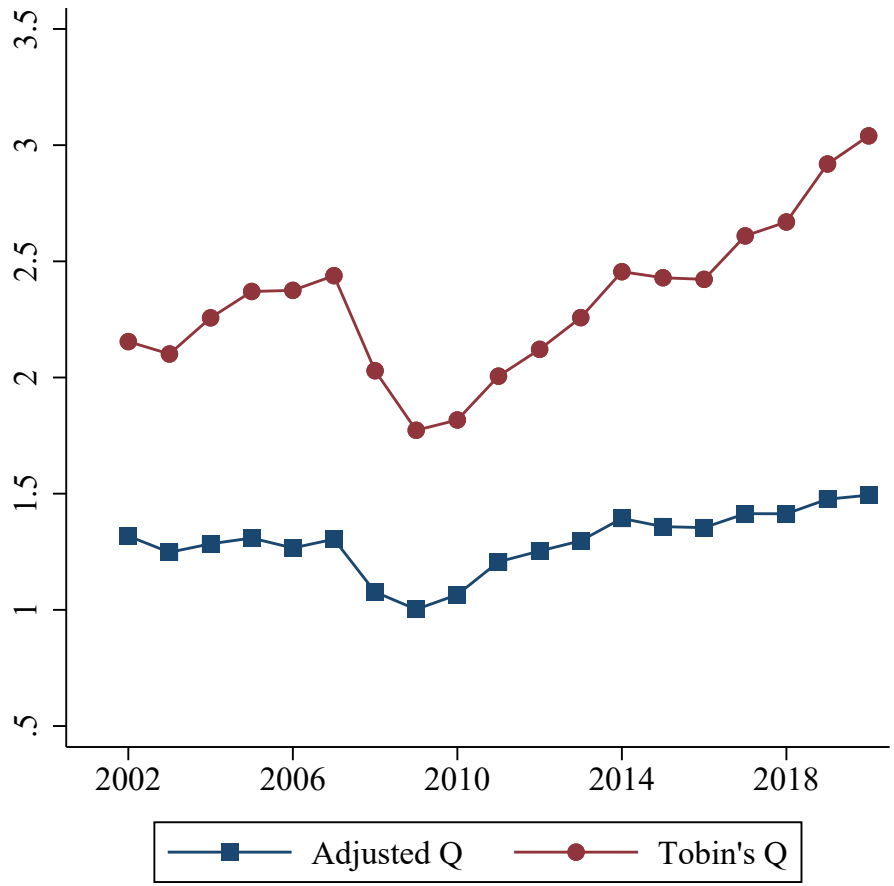
- Focus on $\kappa$—wedges actively chosen by firms
- Recall: large time variation in avg. $\kappa$



# Measuring Adjusted Q

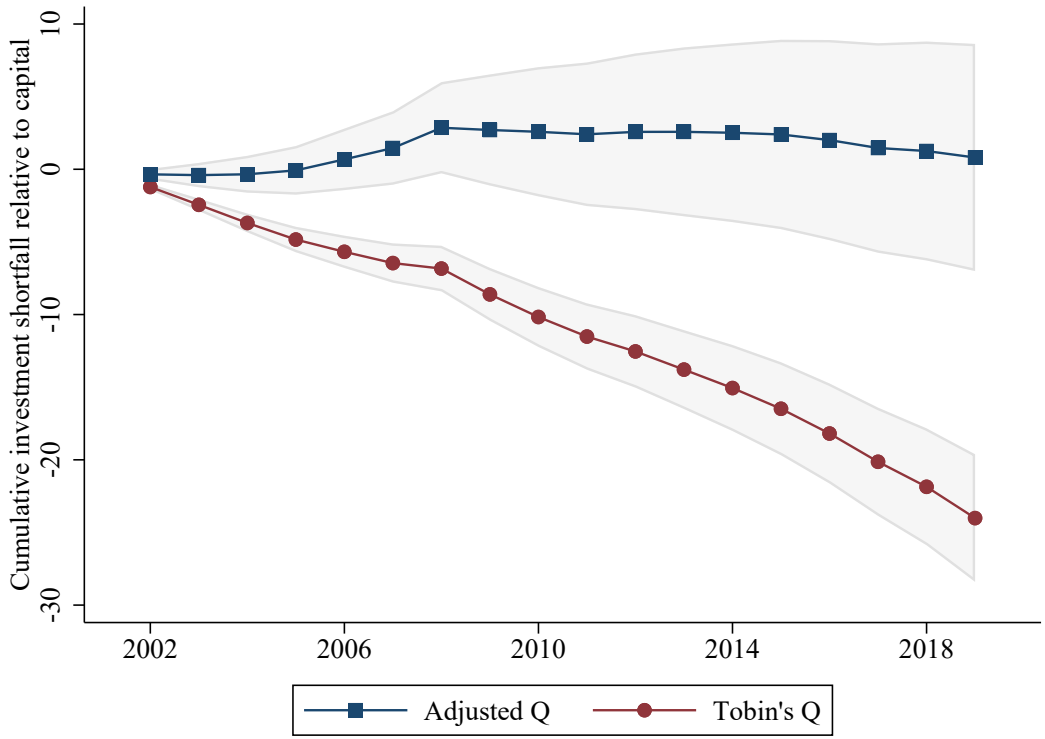
- Adjusted Q more consistent with level and dynamics of investment
- Wedges large enough to account for low investment without relying on mismeasurement or low marginal returns



# Adjusted Q Accounts for Low Investment

Method of Gutiérrez and Philippon (2017)

- Estimate relation btw. Tobin's Q and aggr. investment for 1990-2002
- Predict investment for 2002-2019
- Deviation from prediction is "missing investment," > 20% of capital



# Firm-Level Changes in Tobins' Q and Wedges

Firms that increased their wedges have disproportionately contributed to the rise in aggregate Tobin's Q

| | Tobin's Q | |
|---|---|---|
| Discount rate wedge $\kappa$ | 0.20*** | |
| | (0.078) | |
| Discount rate and COC wedge $\kappa+\upsilon$ | | 0.17*** |
| | | (0.058) |
| Observations | 685 | 685 |
| FE | Firm | Firm |
| Within $R^2$ | 0.015 | 0.012 |

# Investment and the Financial COC

General lesson: wedges decouple investment from fin. prices

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In a standard Q-model (Philippon 2009), a 1 ppt. shock to financial COC changes investment rate by:

- 2 with zero discount rate wedge
- 0.2 with observed average wedge
- Not 0!

# Investment and the Financial COC

General lesson: wedges decouple investment from fin. prices

In a standard Q-model (Philippon 2009), a 1 ppt. shock to financial COC changes investment rate by:

- 2 with zero discount rate wedge
- 0.2 with observed average wedge
- Not 0!

Channels: (1) partial transmission, (2) wedges shorten cash flow duration

Relevant for calibration of investment models and for understanding real impact of fin. shocks

# Drivers of Discount Rate Wedges

# Theories

Take first steps toward understanding drivers

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1) Risk and real options

- When investment is irreversible and risky, investment is postponed (Abel and Eberly 1996, McDonald 2000, Bloom 2009)
- High wedges approximate optimal timing

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- High wedges approximate optimal timing

2) Constraints

- Firms cannot take on all projects due to financial, organizational, or managerial constraints (Jagannathan et al. 2016)

# Theories

Take first steps toward understanding drivers

1) Risk and real options

- When investment is irreversible and risky, investment is postponed (Abel and Eberly 1996, McDonald 2000, Bloom 2009)
- High wedges approximate optimal timing

2) Constraints

- Firms cannot take on all projects due to financial, organizational, or managerial constraints (Jagannathan et al. 2016)

3) Market power

- Market power makes it less costly to maintain wedges
- Potential benefits of higher wedge
  - Signals prudence (Jensen 1986)
  - Buffers against MPK $<$ COC
  - 59% of managers believe that wedges add value

# Drivers of Discount Rate Wedge $\kappa$

| Measure | Theories based on |
|---|---|
| Cross-sectional *b* | |
| Accounts for time var. | |

# Drivers of Discount Rate Wedge $\kappa$

| | Theories based on |
|---|---|
| | Mkt. power |
| Measure | |
| Cross-sectional $b$ | |
| Accounts for time var. | |

# Drivers of Discount Rate Wedge $\kappa$

| | Theories based on | |
|---|---|---|
| | Mkt. power | Risk |
| Measure | | |
| Cross-sectional $b$ | | |
| Accounts for time var. | | |

# Drivers of Discount Rate Wedge $\kappa$

| | Theories based on | | |
|---|---|---|---|
| | Mkt. power | Risk | Constraints |
| Measure | | | |
| Cross-sectional $b$ | | | |
| Accounts for time var. | | | |

# Drivers of Discount Rate Wedge $\kappa$

| | Theories based on | | |
|---|---|---|---|
| | Mkt. power | Risk | Constraints |
| Measure | Acct. markup | Stock volatility | Fin. cons. |
| Cross-sectional $b$ | | | |
| Accounts for time var. | | | |

Cross-sectional regression with standardized regressors:

$$\kappa_t^i = a + b_1 \text{Mkt. power}_{2002}^i + b_2 \text{Risk}_{2002}^i + b_3 \text{Cons.}_{2002}^i + \text{year}_t + \text{country}^i + \varepsilon_t^i$$

# Drivers of Discount Rate Wedge $\kappa$

| | Theories based on | | |
|---|---|---|---|
| | Mkt. power | Risk | Constraints |
| Measure | Acct. markup | Stock volatility | Fin. cons. |
| Cross-sectional $b$ | 0.9** | 1.2** | 0.7* |
| Accounts for time var. | | | |

Cross-sectional regression with standardized regressors:

$$\kappa_t^i = a + b_1 \text{Mkt. power}_{2002}^i + b_2 \text{Risk}_{2002}^i + b_3 \text{Cons.}_{2002}^i + \text{year}_t + \text{country}^i + \varepsilon_t^i$$

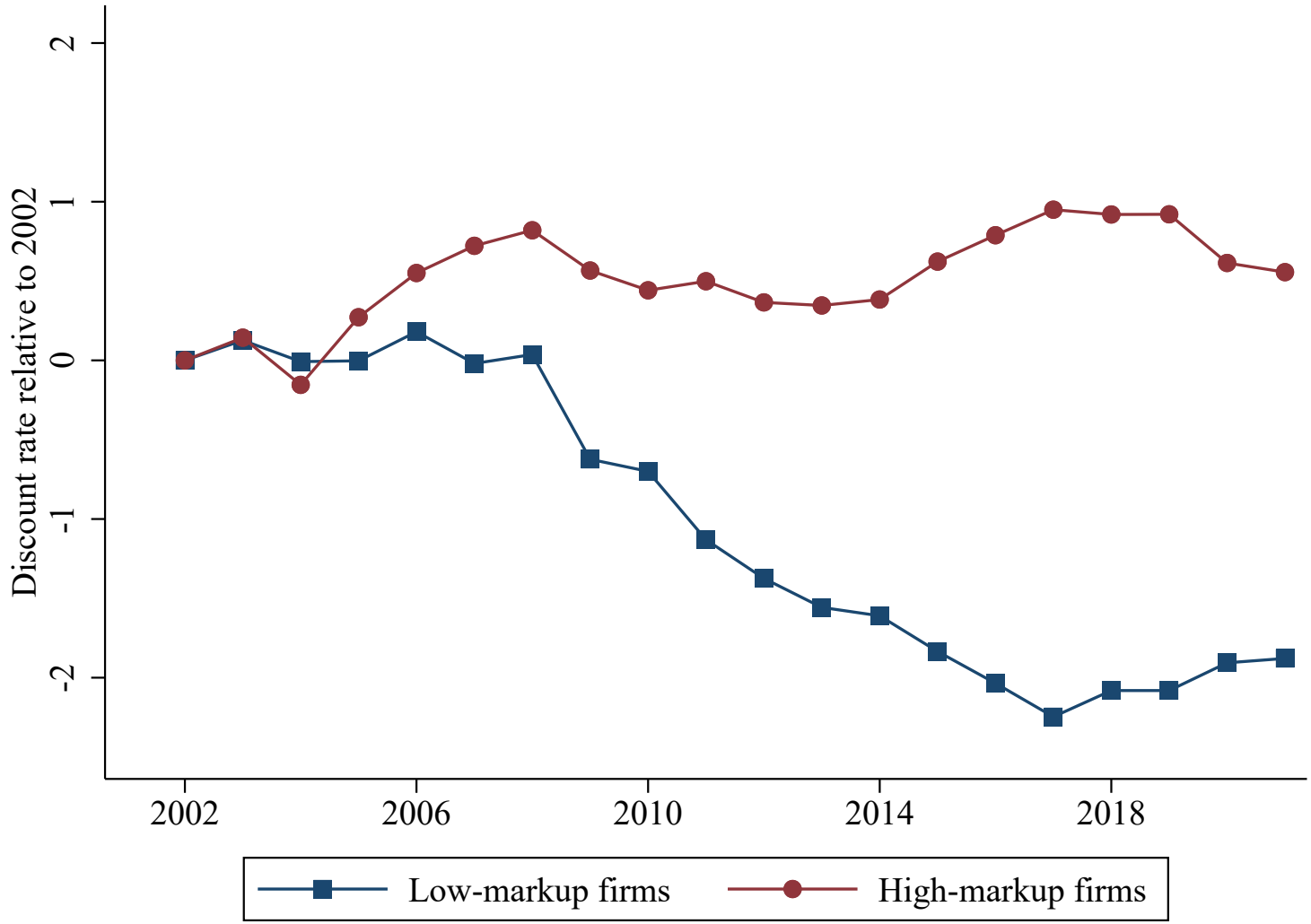
# Drivers of Discount Rate Wedge $\kappa$

| | Theories based on | | |
|---|---|---|---|
| | Mkt. power | Risk | Constraints |
| Measure | Acct. markup | Stock volatility | Fin. cons. |
| Cross-sectional *b* | 0.9** | 1.2** | 0.7* |
| Accounts for time var. | | | |

# Drivers of Discount Rate Wedge $\kappa$

| | Theories based on | | |
|---|---|---|---|
| | Mkt. power | Risk | Constraints |
| Measure | Acct. markup | Stock volatility | Fin. cons. |
| Cross-sectional *b* | 0.9** | 1.2** | 0.7* |
| Accounts for time var. | Yes, secular trend | Yes, short-run fluctuations | Weakly |

# Competition and the Secular Decline in Cost of Capital




Average markup in 2000-02, measured using accounting approach (Baqaee and Farhi 2020), robust to De Loecker et al. (2020) and user-cost approaches

# Competition and the Secular Decline in Cost of Capital

| | Discount rate ($\delta$) | | Disc. rate wedge ($\kappa$) | | Both wedges ($\kappa+\upsilon$) | |
|---|---|---|---|---|---|---|
| Mkt. P. (2002)* | 0.13** | | 0.12** | | 0.12** | |
| Year | (0.069) | | (0.062) | | (0.063) | |
| Mkt. P. (2002)* | | -0.45** | | -0.37** | | -0.40** |
| Avg. perc. COC | | (0.19) | | (0.17) | | (0.16) |
| Observations | 949 | 949 | 949 | 949 | 949 | 949 |
| FE | Firm | Firm | Firm | Firm | Firm | Firm |
| Within $R^2$ | 0.12 | 0.045 | 0.053 | 0.019 | 0.05 | 0.021 |

Std. dev. increase in market power has raised discount rates by 2.5 ppt between 2002 and 2021

Competition determines to what extent firms follow stylized view

# Conclusion

1. New panel dataset of perceived COC, discount rates, and investment
2. New facts on dynamics
   - Financial COC $\Rightarrow$ perceived COC $\approx 0.7$
   - Perceived COC $\Rightarrow$ discount rate $\approx 0.3$
   - Discount rate wedge has increased by 2.5 pp. since 2002
3. Discount rates and investment:
   - Discount rates predict investment
   - Increase in discount rate wedges accounts for recent "missing investment"
4. Drivers
   - Market power limits transmission of COC into discount rates
   - Risk important for short-run fluctuations

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# Project-Specific Discount Rates in Shell

## Disciplined, value-focused capital allocation

| $ billion | Cash Capex 2022 | Cash Capex 2023 | Cash Capex 24-25 | Power dilutions | Cash Capex after power dilutions 24-25 | FCF 2025[1] | IRR hurdle rates |
|---|---|---|---|---|---|---|---|
| IG | 4 | ~5 | ~5 | | ~5 | ~8 | 11% |
| UP | 8 | ~8 | ~8 | | ~8 | ~10 | 15% |
| IGU | 12 | ~13 | ~13 | | ~13 | 17-18 | |
| MKT | 5 | ~6[2] | ~3 | | ~3 | ~4 | MKT ex. LCF/EV 15%<br>LCF 12%<br>EV 12% |
| C&P | 4 | 3-4 | 3-4 | | 3-4 | ~5 | 12% |
| R&ES | 3 | 2-4 | 4-5 | (1-2) | ~3 | ~(2) | R&ES excl. power 10%<br>Power generation 6-8% |
| DSR | 12 | 11-14 | 10-12 | | 9-10 | 7-8 | |
| **Total** | **25** | **23-27** | **22-25** | | **21-23** | **24-26** | |

[1] For price assumptions see appendix [2] Includes acquisition of Nature Energy (nearly $2 billion)

# Realized Returns

| | (1) Realized IRR (same quarter) | (2) Future realized IRR | (3) Future realized IRR |
|---|---|---|---|
| Discount rate | 0.91*** | 0.74*** | 0.79** |
| | (0.14) | (0.096) | (0.38) |
| Observations | 122 | 276 | 276 |
| FE | None | None | Firm |
| $R^2$ | 0.30 | 0.22 | 0.94 |

- Compares realized returns (from calls) to hurdle rates
- Realized returns higher for firms with higher hurdles
- Holds within firm

# Market Power and Discount Rates

Two-period model

$$V_1(\upsilon+\kappa,k) = \max_k \quad k^{1-\theta} - k(r^{\text{fin.}} + \upsilon + \kappa).$$

Cost of higher wedge

- Positive wedge lowers firm value: $\frac{\partial V_1(\upsilon+\kappa,k^*)}{\partial(\upsilon+\kappa)} < 0$, but by less for firm with more market power $\theta$: $\frac{\partial^2 V_1(\upsilon+\kappa,k^*)}{\partial(\upsilon+\kappa)\,\partial\theta} > 0$
- Intuition: higher wedge has an offsetting, positive effect on revenue (through price) for firm with more market power
- Firm with more market power maintains wedge at lower cost

Benefits of higher wedge

- Signal prudence (Jensen 1986)
- Buffer against MPK $<$ COC
- 59% of managers believe that wedges add value