Firms’ Perceived Cost of Capital

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Overview

Data

Measure firms’ discount rates (δ) and perceived cost of capital from conference calls
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Measure firms’ discount rates ($\delta$) and perceived cost of capital from conference calls

$$\delta = \rho_{\text{perc.}}.$$
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Measure firms’ discount rates ($\delta$) and perceived cost of capital from conference calls

$$\delta = \nu_{\text{perc.}} + \kappa$$

Papers on discount rates
1. Corporate Discount Rates
   → Introduces data, studies $\kappa$, shows $\kappa$ accounts for “missing investment”

Papers on the perceived cost of capital
1. Firms’ Perceived Cost of Capital
2. Climate Capitalists
   (with Simon Oh)

See costofcapital.org
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$$\delta = r^{\text{perc.}} + \kappa$$

$$r^{\text{perc.}} = r^{\text{true}}$$
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2. Sticky Discount Rates (with Masao Fukui)
   → DSGE model and monetary non-neutrality

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See costofcapital.org
This Paper

\[ r_{\text{perc.}} = r_{\text{true}} + \nu \]

- Time variation in expected returns on debt and equity
- Some traditional cross-sectional factors
- Only 20% of variation can be justified by \( r_{\text{true}} \)
- 80% of variation reflects mistakes ("excess volatility")
- No mistakes in perc. CoD, large mistakes in perc. CoE

Mistakes lead to misallocation of capital
- Mistakes \( \rightarrow \) misallocation \( \rightarrow \) TFP loss \( \sim 10\% \)
- Allocation closer to optimal if all firms had same perceived coc

Mistakes challenge standard theory
- Challenges premise of production-based theory
- Rejection of Investment-CAPM
This Paper

\[ r^{perc.} = r^{true} + \nu \]

1. \( r^{perc.} \) correctly incorporates
   - time variation in expected returns on debt and equity
   - some traditional cross-sectional factors

But \( r^{perc.} \) is mostly wrong
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Data and Framework
Data from Corporate Conference Calls

Nestlé, Q4-2006: 
"We use an average cost of capital of 7.5%."

Air Canada, Q3-2017: 
"... our weighted average cost of capital of 7.6%."

Phillips 66, Q2-2022: 
"... our weighted average cost of capital of 10%."

Our Approach
- Identify 110k paragraphs containing keywords from 2002-2022
- Manually read and enter numbers with RA team
- Collect numbers related to:
  - Perceived CoC, CoE, and CoD
  - Required returns (discount rates or "hurdle rates")
  - Realized returns
- Separately collect "project-specific" variables from "representative projects"

Overview of data
- Perc. CoC and required returns for 2,500 firms, 20 countries
- Representative, except larger firms (more on next slide)
- Includes 50 of the 100 largest firms in Compustat (3% of universe)
- Included firms account for >40% of market value
- Data under costofcapital.org

Verifiable data
- Calls are repeated high-stakes interactions (Hassan et al. 2019)
- Information from conference calls used in security lawsuits
- Extensive data validation in Gormsen and Huber (2023)
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## Summary Statistics and Representativeness

### Summary statistics

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>mean</th>
<th>p5</th>
<th>p95</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived cost of capital</td>
<td>3,139</td>
<td>8.67</td>
<td>5.30</td>
<td>13.0</td>
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<tr>
<td>Perceived cost of debt</td>
<td>5,165</td>
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<tr>
<td>Perceived cost of equity</td>
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<td>10.3</td>
<td>5.00</td>
<td>15.0</td>
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<td>Discount rate</td>
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Characteristics (cross-sectional percentiles) of included firms:

<table>
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<tr>
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<th>min</th>
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<tr>
<td>Discount rates of capital</td>
<td>59.8</td>
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<td>100.0</td>
<td>58.3</td>
<td>0.2</td>
<td>100.0</td>
</tr>
<tr>
<td>Cost of capital</td>
<td>83.1</td>
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<td>79.4</td>
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<tr>
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<td>23.0</td>
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<td>90.7</td>
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<tr>
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- Included firms are larger, less constrained, and slightly more profitable than average
- Gormsen and Huber (2023): Extensive analysis on representativeness
- Gormsen and Huber (2023): Within-firm timing of inclusion not predictable
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Within-Firm Timing
What is the True Cost of Capital?

\[ r_{\text{perc.}} = r_{\text{true}} + \psi \]
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The true CoC is the return required by investors for providing capital
What is the True Cost of Capital?

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The true CoC is the return required by investors for providing capital.
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\[ r^{perc.} = r^{true} + \nu \]

The true CoC is the return required by investors for providing capital
- Given by the expected return for financial investment with similar risk

The true firm-level CoC
- CoC for project with same risk as overall firm
- Use expected returns on the firm’s debt and equity as CoD and CoE:

\[ r^{true}_{i,t} = \omega_t \times (1 - \text{tax}) \times \text{Cost of debt}_t + (1 - \omega_t) \times \text{Cost of equity}_t \]

\[ = \omega_t \times (1 - \text{tax}) \times E_t[r^{\text{debt}}_i] + (1 - \omega_t) \times E_t[r^{\text{equity}}_i] \]
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\]

\[
= \omega_t \times (1 - \text{tax}) \times E_t[r_{i,\text{debt}}^t] + (1 - \omega_t) \times E_t[r_{i,\text{equity}}^t]
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- This definition leads to maximization of stock prices
What is the True Cost of Capital?

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Definition of \( r^{\text{true}} \) generally not depend on market efficiency
- Requires only that law of one price holds (details)
Stylized Drivers of the Perceived Cost of Capital
Time-Variation in Perceived CoC

US results:

\[ r_{i,t}^{\text{perc.}} = a_0 + 0.59^{***} \times \text{Earnings yield}_t + 0.32^{***} \times \text{Treasury yield}_t + \epsilon_{i,t} \]

Similar results in global sample
Cross-Sectional Variation and Classic Factors

Consistent with Modigliani and Miller (1958) and Fama and French (1993)
A Multivariate Model of the Perceived Cost of Capital

- Lasso selects 11 relevant characteristics for the perc. cost of capital (among 153)
- Slope coefficients for the 11 characteristics (measured in percentiles from 0 to 1):
A Recently Incorporated Factor: Green Versus Brown

“Climate Capitalists” (with Simon Oh) studies CoC for green and brown firms
A Recently Incorporated Factor: Green Versus Brown

“Climate Capitalists” (with Simon Oh) studies CoC for green and brown firms

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

\[ r_{\text{perc.}} = r_{\text{true}} + \nu \]

How much of the variation in \( r_{\text{perc.}} \) comes from \( r_{\text{true}} \) and \( \nu \)?

- Summary statistics suggests that \( r_{\text{perc.}} \) is too volatile to be driven by \( r_{\text{true}} \) alone.

- The 10-90 spread in the perc. cost of equity is 8%.

- Very rare to find stocks with 8% difference in long-run expected returns.

\[ \nu \]
Excess Volatility

$$r_{\text{perc.}} = r^{\text{true}} + \nu$$

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- The 10-90 spread in the perc. cost of equity is 8%
- Very rare to find stocks with 8% difference in long-run expected returns
  \( \rightarrow r_{\text{perc.}} \) likely to be driven, at least in part, by errors (\( \nu \))
Variance Decomposition

\[ r_{\text{perc.}} = r_{\text{true}} + u \]
Variance Decomposition

\[ r_{\text{perc.}} = r_{\text{true}} + \nu \]

Standard variance decomposition:

\[ \text{var} \left( r_{i,t}^{\text{perc.}} \right) = \text{cov} \left( r_{i,t}^{\text{perc.}}, r_{i,t}^{\text{true}} \right) + \text{cov} \left( r_{i,t}^{\text{perc.}}, \nu_{i,t} \right). \]

So,

\[ 1 = \frac{\text{cov} \left( r_{i,t}^{\text{true}}, r_{i,t}^{\text{perc.}} \right)}{\text{var} \left( r_{i,t}^{\text{perc.}} \right)} + \frac{\text{cov} \left( \nu_{i,t}, r_{i,t}^{\text{perc.}} \right)}{\text{var} \left( r_{i,t}^{\text{perc.}} \right)}. \]
Variance Decomposition

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Standard variance decomposition:

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1 = \frac{\text{cov} \left( r_{\text{true}, i,t}, r_{\text{perc.}, i,t} \right)}{\text{var} \left( r_{\text{perc.}, i,t} \right)} + \frac{\text{cov} \left( \nu_{i,t}, r_{\text{perc.}, i,t} \right)}{\text{var} \left( r_{i,t} \right)}
\]

We need a proxy for \( r_{\text{true}} \):

- Measure leverage and cost of debt using accounting data, tax rate 20%
- Two different methods for true cost of equity
  1. Realized returns
  2. Implied cost of capital

Proxy for true cost of equity based on ex-post realized returns (details):

1. Calculate \( r_{\text{realized}, i,t+j} \) by replacing CoE with realized stock returns
2. \( r_{\text{realized}, i,t+j} \) is \( r_{\text{true}, i,t+j} \) plus an unexpected residual
3. Project \( r_{\text{realized}, i,t+j} \) onto \( r_{\text{perc.}, i,t} \) to obtain \( \gamma_{\text{true}} \) (and \( \gamma_{\text{excess}} \))
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3. Project \( r_{i,t+j}^{\text{realized}} \) onto \( r_{i,t}^{\text{perc.}} \) to obtain \( \gamma^{\text{true}} \) (and \( \gamma^{\text{excess}} \)
1. Excess Volatility through Realized Returns

Estimate true cost of equity based on realized returns (details)
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Estimate true cost of equity based on realized returns (details)

![Graph showing excess volatility (γ_{excess}) for different variations within countries and country-years, with and without controls for risk factors.](image)
2. Excess Volatility through Implied Cost of Capital

Estimate true cost of equity based on the “implied cost of capital” (details)
2. Excess Volatility through Implied Cost of Capital

Estimate true cost of equity based on the “implied cost of capital” (details)
Excess Volatility in Perceptions about Equity, not Debt

Estimating the excess volatility in the perceived cost of equity and debt separately
Excess Volatility in Perceptions about Equity, not Debt

Estimating the excess volatility in the perceived cost of equity and debt separately

Cost of equity based on implied cost of capital and cost of debt based on accounting data
Measurement Error Cannot Explain Excess Volatility

- Excess vol. does not arise because of mismeasurement of tax, $\omega$, or $r_{debt}$
- Excess vol. not a product of CME

Perceived cost of capital
Perceived cost of equity
Perceived cost of debt

Excess volatility ($\gamma_{excess}$)

OLS
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Capital Misallocation from Excess Volatility
Excess Volatility and Misallocation

Standard models: mistakes in perceived cost of capital leads to misallocation of capital

We first quantify this effect in the Hsieh and Klenow (2009) model

- In this model, excess volatility maps directly to TFP loss
- Estimated TFP loss around 10%

We next discuss what happens if perceived cost of capital ≠ discount rates
Model

Three layers of production:

1. Representative firm produces output good by combining sector output \((Y_s)\) with sector share \(\theta\)

\[
Y = \prod_{s=1}^{S} Y_s^\theta
\]

2. Sector output is a CES aggregate of firm-level output within sector

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

3. Firms produce using Cobb-Douglas

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

- Perceived cost of capital \(r_{si} = (1 + \tau_{si}) \times r_{si}^{true}\)
- Constant cost of labor (wage)
- \(A_{si}\) and \(r_{si}\) jointly log-normal and \(\tau_{si}\) independent of \(r_{si}^{true}\) and sector
Solution: Misallocation from Excess Volatility

Solution
- TFP loss from misallocation:

$$\log(\text{TFP}) - \log(\text{TFP}^{\tau=0}) =$$

- $\log(\text{TFP}^{\tau=0})$ is TFP if $\tau_i = 0 \forall i$
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\[
\log(\text{TFP}) - \log(\text{TFP}^{\tau=0}) = -\frac{\sigma}{2} \text{var} \left( \log(1 + \tau_i) \right)
\]

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Results

- Calibrate \( \sigma = 5 \) in baseline (evidence suggest 3 to 10)
Solution: Misallocation from Excess Volatility

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- TFP loss from misallocation:

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- Calibrate \(\sigma = 5\) in baseline (evidence suggest 3 to 10)

<table>
<thead>
<tr>
<th>Percentage change in TFP</th>
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<tbody>
<tr>
<td>All excess volatility</td>
</tr>
<tr>
<td>Excess cross-sectional volatility</td>
</tr>
<tr>
<td>Excess volatility implied by realized returns</td>
</tr>
<tr>
<td>Low elasticity of substitution ((\sigma = 3))</td>
</tr>
</tbody>
</table>
Accounting for Discount-Rate Dynamics

- Gormsen and Huber (2023): Percentage CoC influences discount rates and investment
  - Very limited impact of perc. CoC in short run
  - Strong impact in the long run

Long-run impact of perc. CoC:
- Perc. CoC strongly related to ROIC
- Perc. CoC is persistent: AR coefficient around 0.6 at 10-year horizon

Accounting for “sticky discount rates” based on Fukui et al. (2024)
- Models optimal discount rate ($\delta^∗$) in presence of Calvo friction:
  $$\delta^∗_{i,t} = 1 + \bar{r}_{i} - \theta_1 + \bar{r}_{i} r_{perc,i,t} + E_t[\delta^∗_{i,t+1}]$$

- TFP loss with sticky discount rates around 7%
- Incorporating all volatility from discount rate wedges ($\kappa$) substantially increases TFP loss
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Challenges for Standard Theory
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Standard theory endows firms with perfect information about their cost of capital
  - Innocent assumption in many settings
  - But crucial in others...
Challenges for Standard Theory

Standard theory endows firms with perfect information about their cost of capital

- Innocent assumption in many settings
- But crucial in others...

One example: Production-Based Asset Pricing (PBAP)

- PBAP builds on idea that managers have rational expectations about stock returns, hard to reconcile with our findings
- Mistakes in perc. CoC may lead to rejection of PBAP models
- Example: Investment-CAPM
Perceived CoC and the Investment CAPM

Investment CAPM (Hou et al. 2015)
- Theoretical prediction: firms with high past investment have low expected stock returns
- Mechanism: firms have high investment because they have low perceived CoC
- Consistent with data: investment $q$-factor explains future stock returns
Perceived CoC and the Investment CAPM

Investment CAPM (Hou et al. 2015)
- Theoretical prediction: firms with high past investment have low expected stock returns
- Mechanism: firms have high investment because they have low perceived CoC
- Consistent with data: investment $q$-factor explains future stock returns

We reject the mechanism
- Firms with high investment have high perceived CoC
- The investment factor is not a product of optimal capital budgeting behavior
Testing the Investment CAPM

- Perc. CoC is higher (not lower) for high investment
- High investment of high-investment firms not driven by low perceived cost of capital
## Testing the Investment CAPM

<table>
<thead>
<tr>
<th></th>
<th>All firm/quarters</th>
<th>Firm/quarters with observed perceived cost of capital</th>
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<tbody>
<tr>
<td></td>
<td>Realized stock returns</td>
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<tr>
<td>Asset expansion</td>
<td>-1.43** (0.61)</td>
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<td>Controls:</td>
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<tr>
<td>Profits bins</td>
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</tr>
<tr>
<td>Observations</td>
<td>739,481 723,243 722,926</td>
<td>1,352 1,334 1,334 2,000 1,960 1,960</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.118 0.158 0.183</td>
<td>0.215 0.230 0.264 0.187 0.217 0.345</td>
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Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1
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- Asset expansion (investment) indicates that high investment is associated with higher realized stock returns, controlling for other factors.
- High investment of high-investment firms is not driven by low future returns.
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- Perc. CoC is higher (not lower) for high investment
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Conclusions

Economist endow firms with perfect knowledge of CoC
  - But CoC hard to estimate → errors likely

New facts on firms perc. CoC
  - 20% of variation “correct”
  - But 80% of variation represents mistakes

Large economic consequences of mistakes in perc. CoC
  - Mistakes → 10% TFP loss
  - Capital closer to optimal if all firms used same CoC
  - Is current MBA curriculum counterproductive?

Plea: More research on these classical topics
  - How should firms estimate their CoC?
  - Should firms incorporate uncertainty about CoC in cap. budgeting?
  - How do mistakes in perc. CoC hurt stock prices?
Thank You!
References


Market Efficiency and True Cost of Capital

$r^{\text{true}}$ does not depend on market efficiency in general

- Assume prices driven by “behavioral demand” but law of one price holds
- Firms maximize value by discounting cash flows ($X$) using the SDF ($M$):

\[
\max \sum_{i=1}^{\infty} E_t(M_{t+i}X_{t+i})
\]

- Leads to similar rule as WACC formula
- Intuition: expected returns capture required return of marginal arbitrageur

Rule may differ if firms maximize future stock prices

- Firms use expected future SDF to discount cash flows
- Equivalent to using “future expected returns”
- Can explain “missing variation”, but not the large excess volatility
1. Excess Volatility through Realized Returns: Details

Estimate true cost of equity based on realized returns:

1. Define realized stock returns for firm $i$ as

$$r_{i,t+j}^{\text{equity, realized}} = E_t[r_{i,t}^{\text{equity}}] + e_{i,t+j}$$

2. Define,

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

3. Then,

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

⇒ We can recover $r_{i,t}^{\text{true}}$ and $r_{i,t}^{\text{excess}}$ through projection of $r_{i,t+j}^{\text{realized}}$ on $r_{i,t}^{\text{perc.}}$
2. Excess Volatility through Implied Cost of Capital: Details

Estimate true cost of equity based on the “implied cost of capital” (ICC)
- Standard measure of long-run expected returns
- Backs out expected returns from prices and expected cash flows

ICC is a noisy predictor of expected returns
- Predictive regressions give
\[ R_{i,t+j}^{\text{realized}} = \alpha + 0.t_{i,t}^{\text{ICC}} + \epsilon_{i,t+j} \]

- I.e., excess volatility in the ICC
- We can extract \( \gamma^{\text{excess}} \) under the assumption that \( r_{i,t}^{\text{ICC}} = r_{i,t}^{\text{true}} + \text{noise}_{i,t} \)
Cost of Capital Factor

1. Does the perceived CoC include variation that is not in $\mu$?
   - Alternative approach: factor regression
Cost of Capital Factor

1. Does the perceived CoC include variation that is not in $\mu$?
   - Alternative approach: factor regression
   - Address using CoC factor (Fama and French 1993-type factor)
   - Use most recently observed perceived CoC (< 10 years old)
   - Factor not strongly associated with returns, but with market, size, and value

<table>
<thead>
<tr>
<th></th>
<th>(1) Perceived. CoC$_t$</th>
<th>(2) Realized return$_{r,t+1}$</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.41***</td>
<td>0.0067</td>
<td>-0.17</td>
<td>-0.11</td>
</tr>
<tr>
<td></td>
<td>(0.0026)</td>
<td>(0.18)</td>
<td>(0.17)</td>
<td>(0.15)</td>
</tr>
<tr>
<td>MKT$_{t,t+1}$</td>
<td></td>
<td>0.25***</td>
<td>0.16***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.037)</td>
<td>(0.036)</td>
<td></td>
</tr>
<tr>
<td>SMB$_{t,t+1}$</td>
<td></td>
<td></td>
<td>0.27***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.066)</td>
<td></td>
</tr>
<tr>
<td>HML$_{t,t+1}$</td>
<td></td>
<td></td>
<td>0.26***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.049)</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>216</td>
<td>216</td>
<td>216</td>
<td>216</td>
</tr>
<tr>
<td>P(intercept = 0.41)</td>
<td>0.026</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-squared</td>
<td>0.000</td>
<td>0.000</td>
<td>0.173</td>
<td>0.355</td>
</tr>
</tbody>
</table>

Standard errors in parentheses, *** $p<0.01$
Which Factors Are Reflected in Per. Coc?

- Estimate relation between $\lambda^{\text{implied}}$ and $\lambda^{\text{true}}$ for different groups (Cho and Polk (2019))
- Reasonable relation within “traditional” factors
- Little to no relation for other factors
“As If” Behavior Cannot Save the Investment CAPM

“As if” hypothesis: high investment firms “know” they should require low returns
Test: look at required returns (discount rates/hurdles) from Gormsen and Huber (2023)

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
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<tbody>
<tr>
<td>Firm required return</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asset expansion</td>
<td>0.012</td>
<td>0.029***</td>
<td>0.012</td>
</tr>
<tr>
<td>(investment)</td>
<td>(0.010)</td>
<td>(0.011)</td>
<td>(0.0089)</td>
</tr>
</tbody>
</table>

Controls:
- Profits bins: X
- Beta bins: X
- Size bins: X

Observations: 1,896, 1,816, 1,816
R-squared: 0.130, 0.198, 0.286
FE Country/date, Country/date, Country/date
Cluster Firm/date, Firm/date, Firm/date

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

- Note: required returns reduce investment once conditioning properly on investment opportunities (e.g., firm FE)