Lecture Notes

Liu, Whited, and Zhang (2009, J. of Political Economy): Investment-Based Expected Stock Returns

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Outline

Outline

Introduction

What

We derive and test q-theory implications for the cross-section of expected stock returns

Introduction

Motivation: Many characteristics-return relations in capital markets research

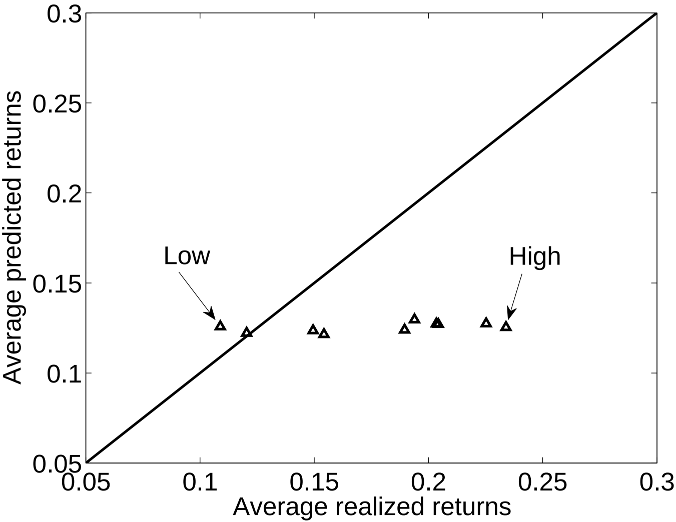
$$\overbrace{r_{jt+1}}^{\textbf{Realized returns}} = \underbrace{E_t[r_{jt+1}]}_{\textbf{Expected returns}} + \overbrace{\epsilon_{jt+1}}^{\textbf{Abnormal returns}}$$

Use the q-theory of investment to link expected returns to firm characteristics

Outline

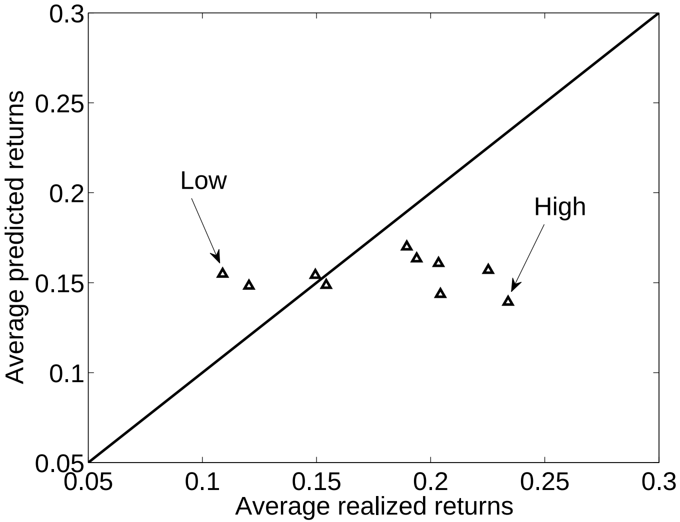
Key Results

Average predicted vs. realized returns, ten SUE portfolios, the CAPM



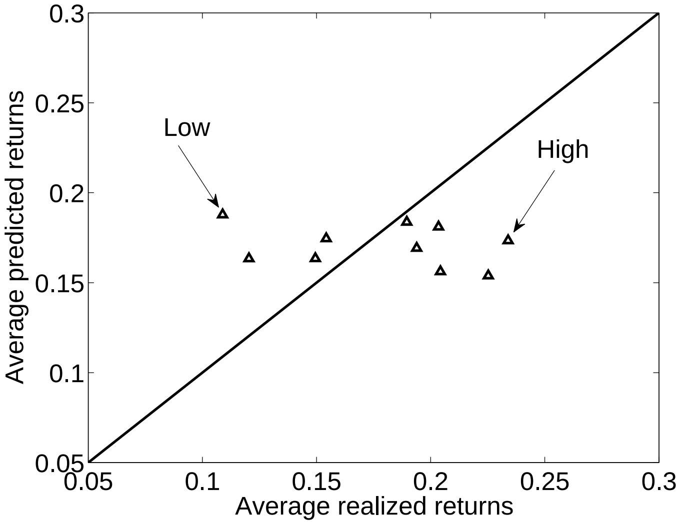
Key Results

Average predicted vs. realized returns, ten SUE portfolios, the Fama-French model



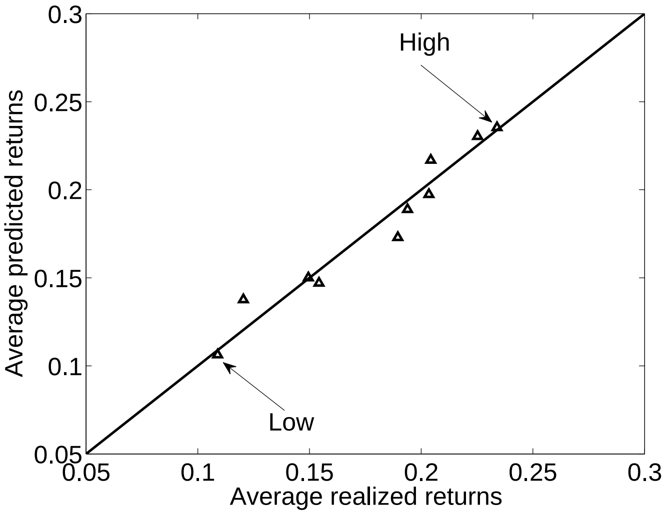
Key Results

Average predicted vs. realized returns, ten SUE portfolios, the consumption-CAPM



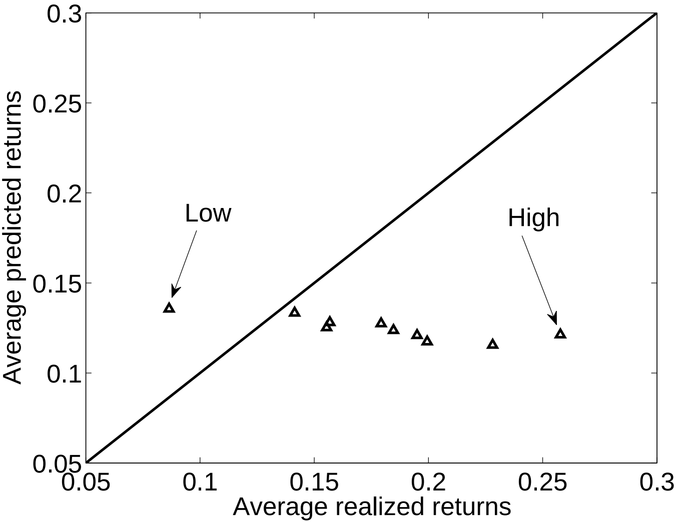
Key Results

Average predicted vs. realized returns, ten SUE portfolios, the q-theory model



Key Results

Average predicted vs. realized returns, ten B/M portfolios, the CAPM



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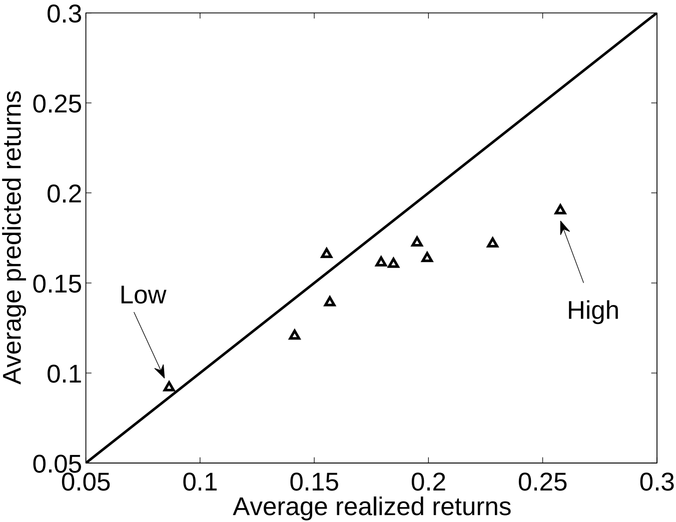
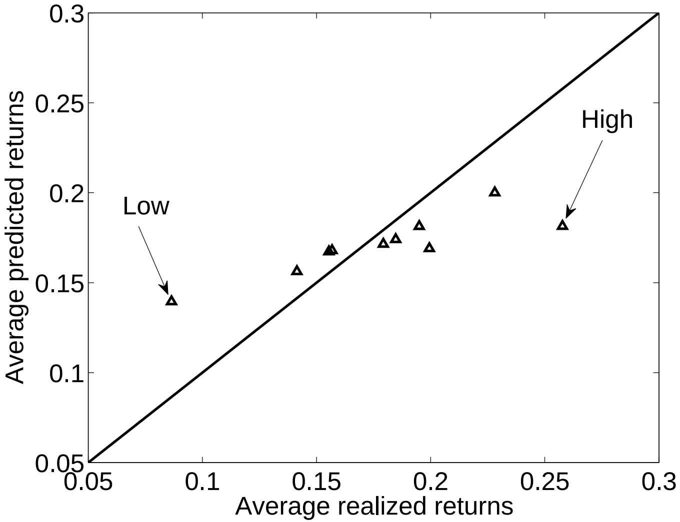


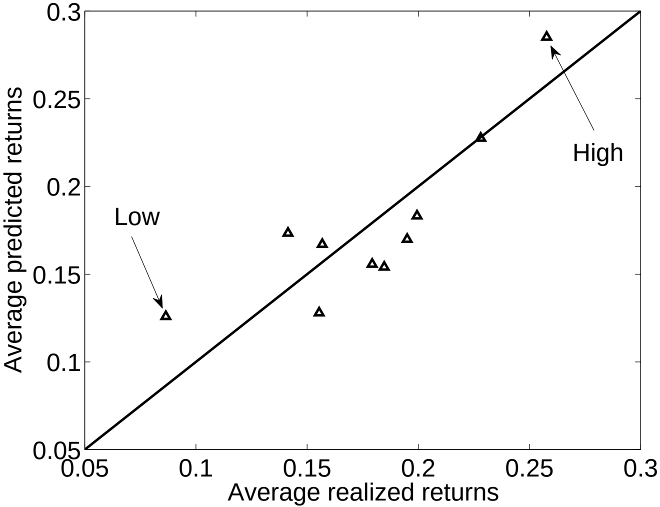
Key Results

Average predicted vs. realized returns, ten B/M portfolios, the consumption-CAPM



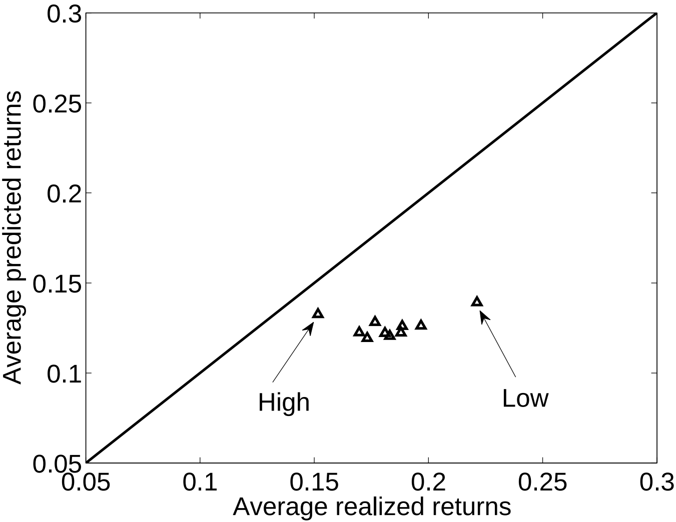
Key Results

Average predicted vs. realized returns, ten B/M portfolios, the q-theory model



Key Results

Average predicted vs. realized returns, ten CI portfolios, the CAPM



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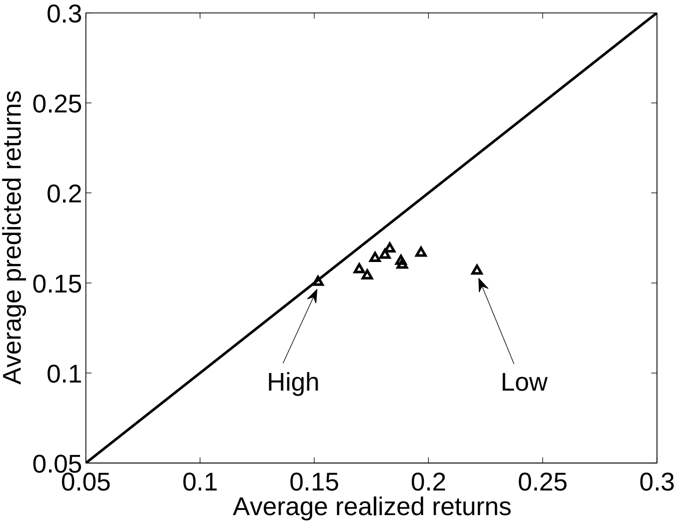
Average predicted vs. realized returns, ten CI portfolios, the Fama-French model



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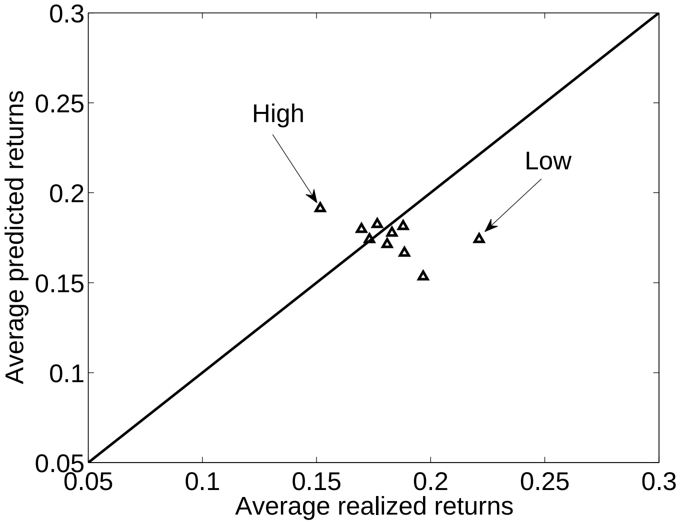
Average predicted vs. realized returns, ten CI portfolios, the consumption-CAPM



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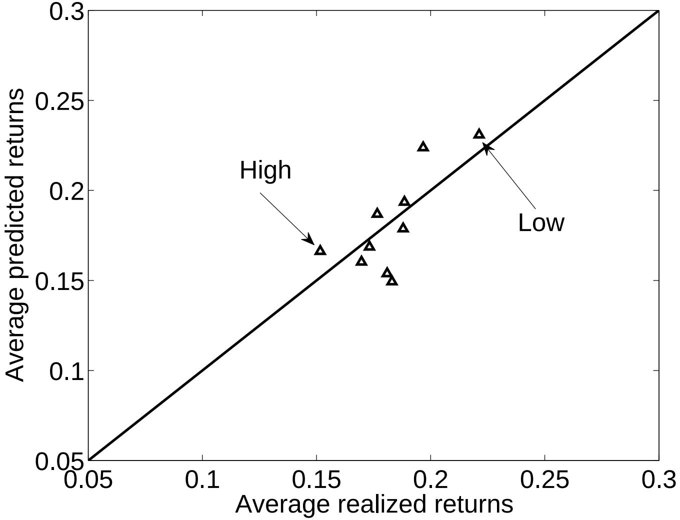
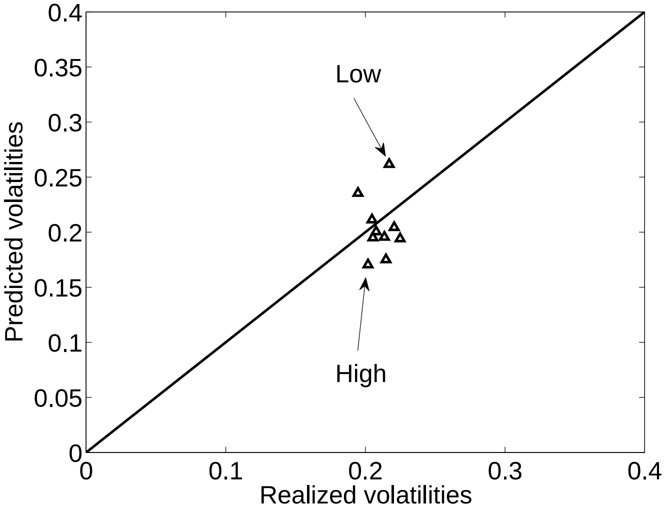
Average predicted vs. realized returns, ten CI portfolios, the q-theory model



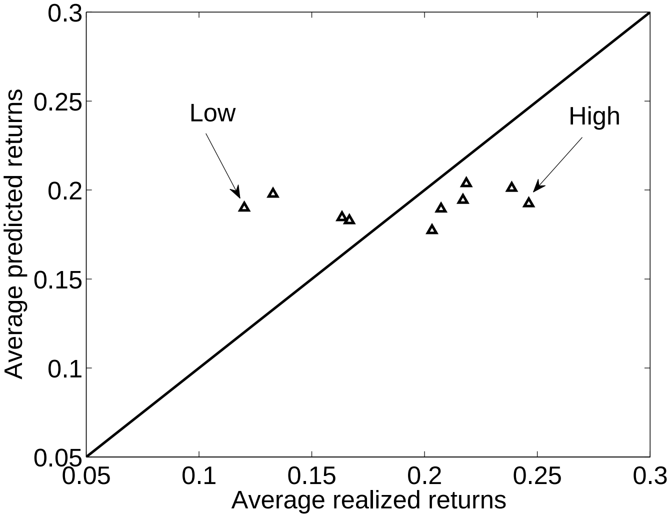
Key Results

Predicted vs. realized stock return volatilities, joint estimation of mean and variance, the q-theory model



Key Results

Average predicted vs. realized returns, joint estimation of mean and variance, the q-theory model



Outline

Model

The neoclassical q-theory framework à la Cochrane (1991). Firms use capital and costlessly adjustable inputs such as labor

Operating profits, $\Pi(K_{it}, X_{it})$, with

$$\frac{\partial \Pi(K_{it}, X_{it})}{\partial K_{it}} = \alpha \frac{Y_{it}}{K_{it}} \quad \text{with } Y_{it} = \text{Sales}$$

Capital evolves as:

$$K_{it+1} = I_{it} + (1 - \delta_{it}) K_{it}$$

Convex adjustment costs:

$$\Phi(I_{it}, K_{it}) = \frac{a}{2} \left(\frac{I_{it}}{K_{it}} \right)^2 K_{it}$$

Model

Equity-value maximization

One-period debt, B_{it+1}, with corporate bond return r^B_{it+1}

Payout, D_{it}, defined as:

$$(1-\tau_t)[\Pi(K_{it}, X_{it})-\Phi(I_{it}, K_{it})]-I_{it}+B_{it+1}-r^B_{it}B_{it}+\tau_t\delta_{it}K_{it}+\tau_t(r^B_{it}-1)B_{it}$$

The cum-dividend market value of the equity:

$$V_{it} \equiv \max_{\{I_{it+s}, K_{it+s+1}, B_{it+s+1}\}_{s=0}^{\infty}} E_t\left[\sum_{s=0}^{\infty} M_{t+s}D_{it+s}\right]$$

in which M_{t+1} is the stochastic discount factor, correlated with X_{it+1}

Model

The investment return

$E_t[M_{t+1} r^I_{it+1}] = 1$, in which r^I_{it+1} is the investment return:

$$r^I_{it+1} \equiv \frac{\overbrace{\left[\begin{array}{c}\underbrace{(1-\tau_{t+1})\left[\alpha \frac{Y_{it+1}}{K_{it+1}} + \frac{a}{2}\left(\frac{I_{it+1}}{K_{it+1}}\right)^2\right]}_{\textbf{Marginal product plus economy of scale (net of taxes)}} \\ +\tau_{t+1}\delta_{it+1} + \underbrace{(1-\delta_{it+1})\left[1+(1-\tau_{t+1})a\left(\frac{I_{it+1}}{K_{it+1}}\right)\right]}_{\textbf{Expected continuation value}}\end{array}\right]}^{\textbf{Marginal benefit of investment at time } t+1}}{\underbrace{1+(1-\tau_t)\left(\frac{I_{it}}{K_{it}}\right)}_{\textbf{Marginal cost of investment at time } t}}$$

Model

The WACC Proposition

Define $r^{Ba}_{it+1} = (1 - \tau_{t+1}) r^{B}_{it+1} + \tau_{t+1}$, then $E_t \left[M_{t+1} r^{Ba}_{it+1} \right] = 1$

Define $P_{it} \equiv V_{it} - D_{it}$ and the stock return $r^{S}_{it+1} \equiv (P_{it+1} + D_{it+1})/P_{it}$

Under constant returns to scale, the investment return is the weighted average of stock and after-tax bond returns:

$$r^{I}_{it+1} = w_{it} r^{Ba}_{it+1} + (1 - w_{it}) r^{S}_{it+1} \;\Rightarrow\; r^{S}_{it+1} = r^{Iw}_{it+1} \equiv \frac{r^{I}_{it+1} - w_{it} r^{Ba}_{it+1}}{1 - w_{it}}$$

in which w_{it} is market leverage, $w_{it} \equiv B_{it+1}/(P_{it} + B_{it+1})$

Outline

Do expected stock returns equal expected levered investment returns?

$$E\left[r_{it+1}^{S} - r_{it+1}^{Iw}\right] = 0$$

Do stock return variances equal levered investment return variances?

$$E\left[\left(r_{it+1}^{S} - E\left[r_{it+1}^{S}\right]\right)^{2} - \left(r_{it+1}^{Iw} - E\left[r_{it+1}^{Iw}\right]\right)^{2}\right] = 0$$

Econometric Methods

Testing portfolios

Three sets of testing portfolios

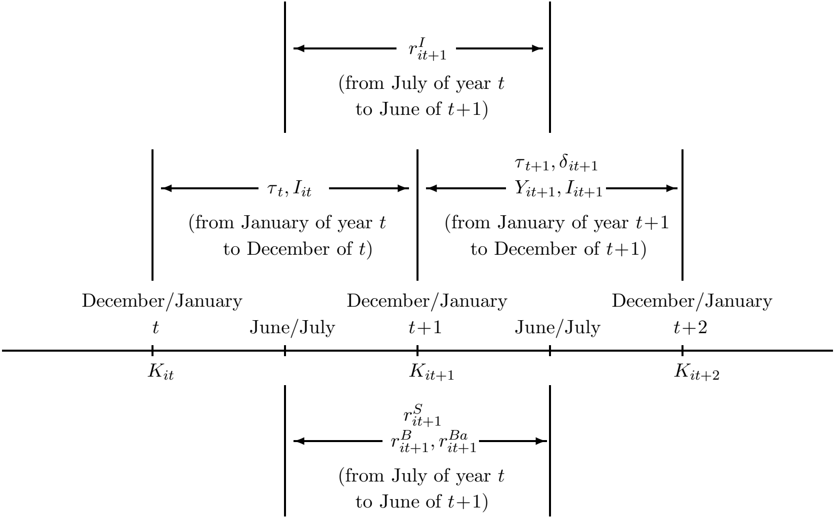
- Ten Standardized Unexpected Earnings (SUE) portfolios of Chan, Jegadeesh, and Lakonishok (1996)
- Ten book-to-market portfolios as in Fama and French (1993)
- Ten "abnormal" investment portfolios of Titman, Wei, and Xie (2004)

Why portfolios?

- Larger and more reliable expected return spreads across portfolios than across individual stocks
- Smoothing lumpy investment as in Thomas (2002)

Econometric Methods

Timing



Econometric Methods

Measurement

- K_{it}: gross property, plant, and equipment
- I_{it}: capital expenditure minus sales of property, plant, and equipment
- Y_{it}: sales
- B_{it}: total long-term debt
- P_{it}: market value of common equity
- δ_{it}: the amount of depreciation divided by capital
- r^B_{it+1}: impute bond ratings, assign corporate bond returns of a given rating to all firms with the same rating
- τ_t: statutory tax rate of corporate income

Outline

Expected Stock Returns

Point estimates and tests of overidentification

	SUE	B/M	CI
a	7.68	22.34	0.97
[ste]	[1.72]	[25.47]	[0.29]
α	0.32	0.50	0.21
[ste]	[0.03]	[0.31]	[0.02]
χ^2	4.37	5.99	6.52
d.f.	8	8	8
p	0.82	0.65	0.59
m.p.e.	0.74	2.32	1.51

Expected Stock Returns

Euler equation errors, ten SUE portfolios

	Low	5	High	H−L	$[t_{\mathrm{H-L}}]$
	Panel A: Ten SUE portfolios				
e_i	−1.69	6.56	10.86	12.55	[5.53]
e_i^{FF}	−4.59	1.96	9.47	14.06	[5.31]
e_i^{C}	−8.07	−0.04	5.31	13.38	[1.35]
e_i^{q}	0.26	1.66	−0.15	−0.40	[−0.41]

Expected Stock Returns

Euler equation errors, ten B/M portfolios

	Low	5	High	H−L	$[t_{\mathrm{H-L}}]$
	Panel B: Ten B/M portfolios				
e_i	−4.91	5.19	13.65	18.56	[2.51]
e_i^{FF}	−0.54	1.80	6.76	7.30	[3.25]
e_i^{C}	−5.43	0.27	6.88	12.31	[0.26]
e_i^{q}	−3.94	2.35	−2.73	1.21	[0.79]

Expected Stock Returns

Euler equation errors, ten CI portfolios

	Low	5	High	H−L	$[t_{\text{H}-\text{L}}]$
	Panel C: Ten CI portfolios				
e_i	8.21	5.89	1.91	−6.30	[−3.88]
e_i^{FF}	6.45	1.54	0.11	−6.34	[−3.99]
e_i^{C}	4.03	0.46	−4.35	−8.38	[−1.35]
e_i^{q}	−0.97	2.72	−1.45	−0.49	[−0.41]

Expected Stock Returns

Economic determinants of expected stock returns

$$r^I_{it+1} \equiv \frac{(1-\tau_{t+1})\left[\alpha \frac{Y_{it+1}}{K_{it+1}} + \frac{a}{2}\left(\frac{I_{it+1}}{K_{it+1}}\right)^2\right] + \tau_{t+1}\delta_{it+1} + (1-\delta_{it+1})\left[1 + (1-\tau_{t+1})a\left(\frac{I_{it+1}}{K_{it+1}}\right)\right]}{1 + (1-\tau_t)a\left(\frac{I_{it}}{K_{it}}\right)}$$

$$r^{Iw}_{it+1} \equiv \frac{r^I_{it+1} - w_{it} r^{Ba}_{it+1}}{1 - w_{it}}$$

Determinants: $Y_{it+1}/K_{it+1}, I_{it+1}/I_{it}, \delta_{it+1}$, and I_{it}/K_{it}, also w_{it} and r^B_{it+1}

Expected Stock Returns

Characteristics, ten SUE portfolios

	Low	5	High	H−L	$[t_{\mathrm{H-L}}]$
I_{it}/K_{it}	0.12	0.11	0.12	0.00	[0.70]
$(I_{it+1}/K_{it+1})/(I_{it}/K_{it})$	0.89	1.00	1.06	0.17	[4.06]
Y_{it+1}/K_{it+1}	1.52	1.50	1.83	0.31	[5.16]
δ_{it+1}	0.08	0.08	0.08	0.00	[0.63]
w_{it}	0.30	0.28	0.21	−0.10	[−5.83]
r^B_{it+1}	9.44	9.76	9.38	−0.06	[−0.27]

Expected Stock Returns

Expected returns accounting, ten SUE portfolios

	Low	5	High	H−L
$\overline{I_{it}/K_{it}}$	−2.48	4.45	−4.26	−1.78
$\overline{q_{it+1}/q_{it}}$	−5.23	1.76	3.62	8.85
$\overline{Y_{it+1}/K_{it+1}}$	−0.78	0.39	3.53	4.31
$\overline{w}_{it}$	0.13	1.89	−1.46	−1.58

Expected Stock Returns

Characteristics, ten B/M portfolios

	Low	5	High	H−L	$[t_{\text{H−L}}]$
I_{it}/K_{it}	0.18	0.11	0.08	−0.10	[−7.95]
$(I_{it+1}/K_{it+1})/(I_{it}/K_{it})$	0.98	1.00	1.02	0.04	[0.68]
Y_{it+1}/K_{it+1}	1.95	1.45	1.38	−0.57	[−6.77]
δ_{it+1}	0.10	0.07	0.07	−0.03	[−5.01]
w_{it}	0.08	0.27	0.53	0.44	[12.44]
r^B_{it+1}	8.17	8.09	8.52	0.35	[1.05]

Expected Stock Returns

Expected returns accounting, ten B/M portfolios

	Low	5	High	H−L
$\overline{I_{it}/K_{it}}$	−42.06	4.69	48.17	90.23
$\overline{q_{it+1}/q_{it}}$	−1.92	2.11	−4.06	−2.14
$\overline{Y_{it+1}/K_{it+1}}$	0.16	0.92	−6.33	−6.49
$\overline{w}_{it}$	−6.00	2.19	5.58	11.58

Expected Stock Returns

Characteristics, ten CI portfolios

	Low	5	High	H−L	$[t_{\text{H}-\text{L}}]$
I_{it}/K_{it}	0.09	0.11	0.16	0.07	[11.06]
$(I_{it+1}/K_{it+1})/(I_{it}/K_{it})$	1.25	1.04	0.81	−0.44	[−7.23]
Y_{it+1}/K_{it+1}	1.84	1.58	1.89	0.05	[0.38]
δ_{it+1}	0.08	0.07	0.08	0.00	[−0.46]
w_{it}	0.35	0.25	0.28	−0.07	[−2.59]
r^{B}_{it+1}	8.47	8.27	8.44	−0.03	[−0.15]

Expected Stock Returns

Expected returns accounting, ten CI portfolios

	Low	5	High	H−L
$\overline{I_{it}/K_{it}}$	2.86	3.50	−5.67	−8.53
$\overline{q_{it+1}/q_{it}}$	0.73	2.97	−3.87	−4.60
$\overline{Y_{it+1}/K_{it+1}}$	0.57	−0.44	0.09	−0.48
$\overline{w}_{it}$	1.80	2.61	−0.91	−2.71

Outline

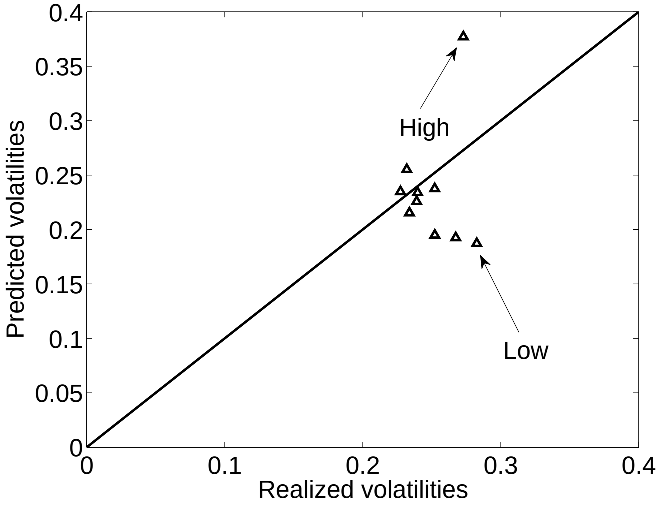
Joint Estimation

Point estimates and tests of overidentification

	SUE	B/M	CI
a	28.88	11.48	16.23
[ste]	[16.25]	[4.75]	[5.53]
α	0.61	0.35	0.36
[ste]	[0.27]	[0.07]	[0.08]
$\chi^2_{(2)}$	5.14	6.18	6.05
d.f.(2)	8	8	8
$p(2)$	0.74	0.63	0.64
m.p.e.(2)	0.03	0.04	0.02
$\chi^2_{(1)}$	5.22	4.38	4.81
d.f.(1)	8	8	8
$p(1)$	0.73	0.82	0.78
m.p.e.(1)	3.45	2.58	2.22
χ^2	5.45	6.17	6.62
d.f.	18	18	18
p	1.00	1.00	0.99

Joint Estimation

Predicted vs. realized stock return volatilities, ten B/M portfolios, the q-theory model



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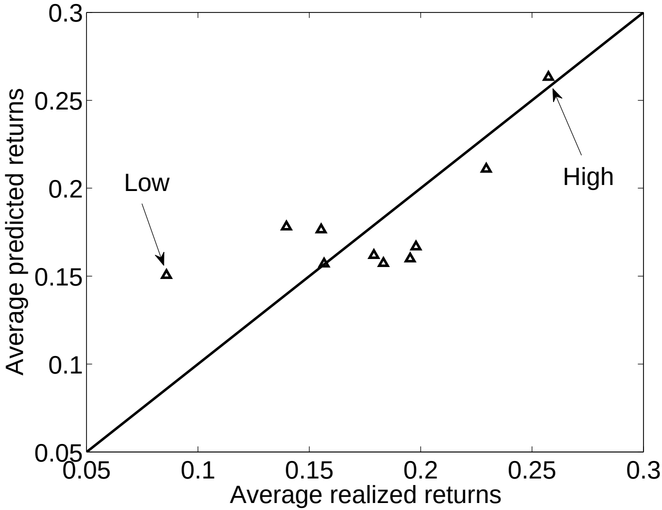
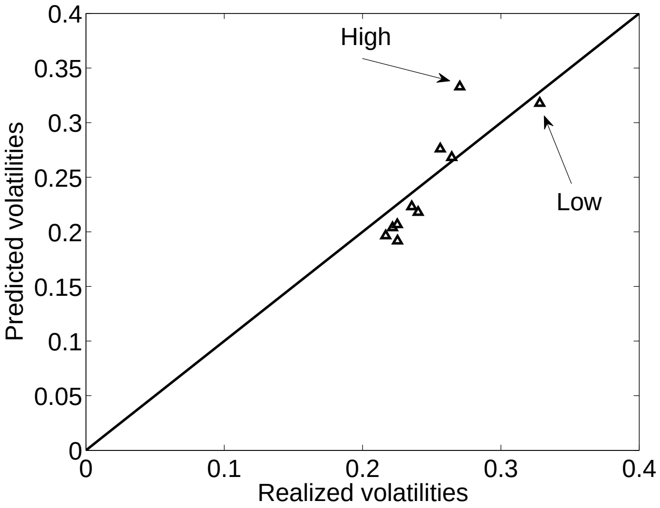


Joint Estimation

Predicted vs. realized stock return volatilities, ten CI portfolios, the q-theory model



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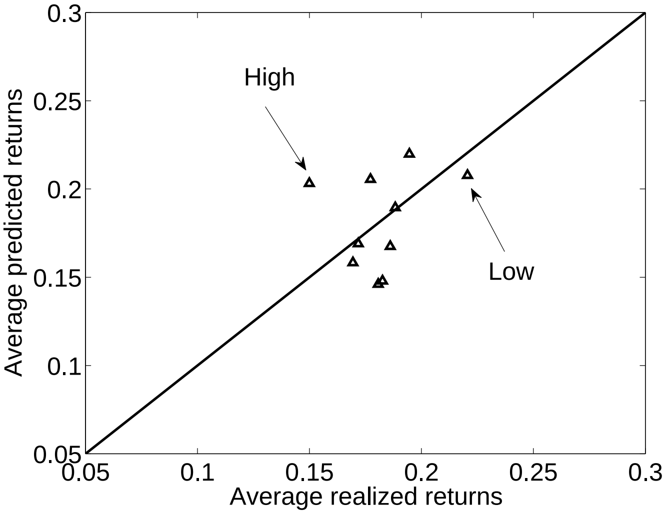

Outline

Conclusion

Summary and interpretation

Summary: Derive and test the q-theory model for cross-sectional returns

Interpretation: Portfolios of firms do a good job in aligning their investment policies with costs of equity capital, and this alignment drives many characteristics-return relations

Conclusion

Future Work

More realistic ingredients (decreasing returns, investment lags, financing constraints, labor, organizational capital):

- Balance realism and analytical tractability, empirical challenges (data limitations)

More puzzles in cross-sectional returns (momentum, asset growth, accruals, distress, M&As, net equity issues, governance)

An investment-based theory of corporate bond returns

Belo, Xue, and Zhang (2010): Cross-sectional Tobin's Q

Methodology applicable in dynamic corporate finance