

Lecture Notes

Liu, Whited, and Zhang (2009, Journal of Political Economy, "Investment-Based Expected Stock Returns")

Lu Zhang¹

¹Ohio State and NBER

FIN 8250, Autumn 2021
Ohio State

Introduction

Theme

A first stab at GMMing the investment CAPM

Introduction

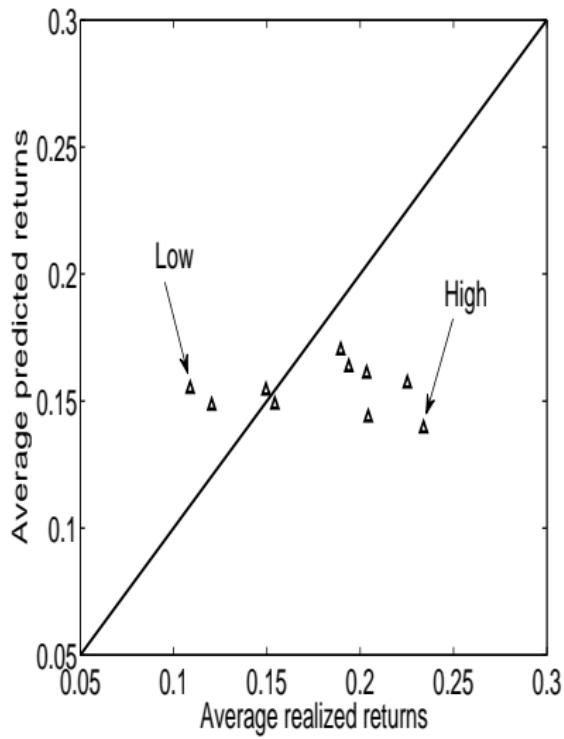
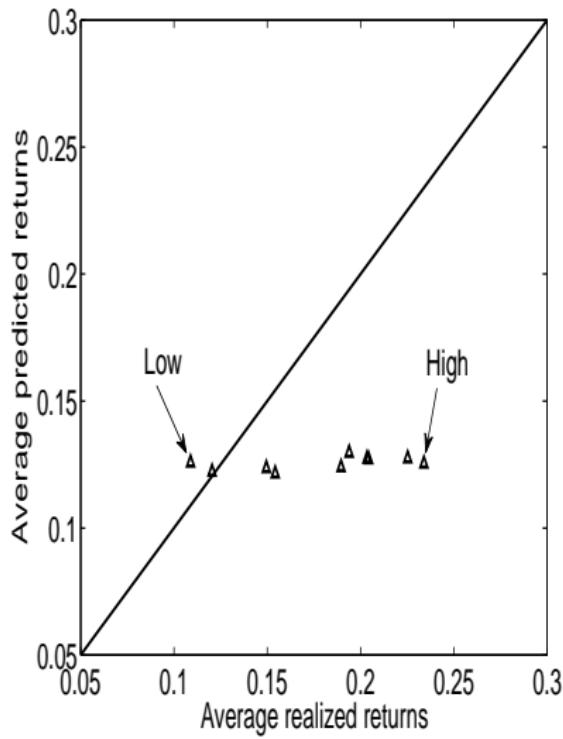
Motivation: Many characteristics-return relations in asset pricing

$$\text{Realized returns} \quad \hat{r}_{jt+1} = \underbrace{E_t[r_{jt+1}]}_{\text{Expected returns}} + \hat{\epsilon}_{jt+1} \quad \text{Abnormal returns}$$

The investment CAPM links expected returns to firm characteristics

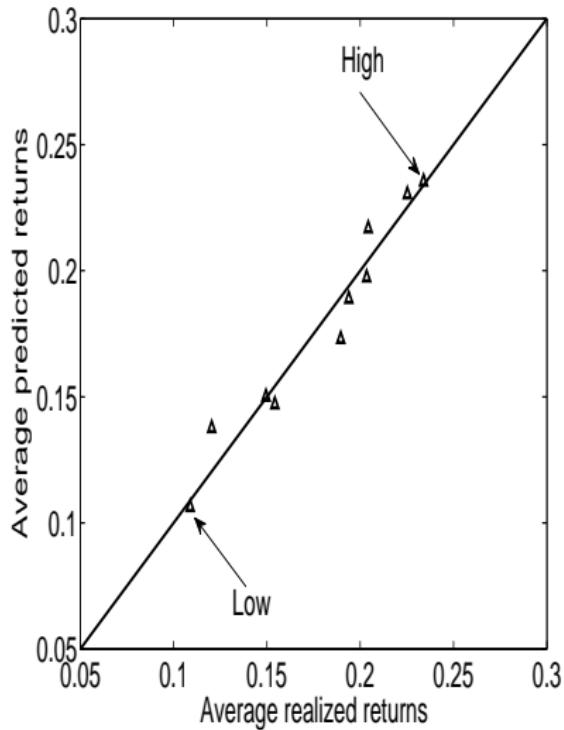
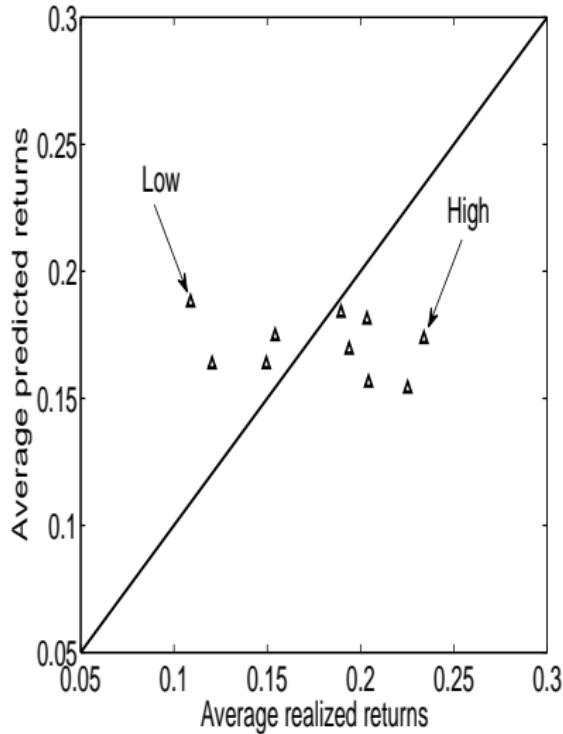
Introduction

Preview: Average predicted vs. realized returns, the SUE deciles, the CAPM and the Fama-French 3-factor model



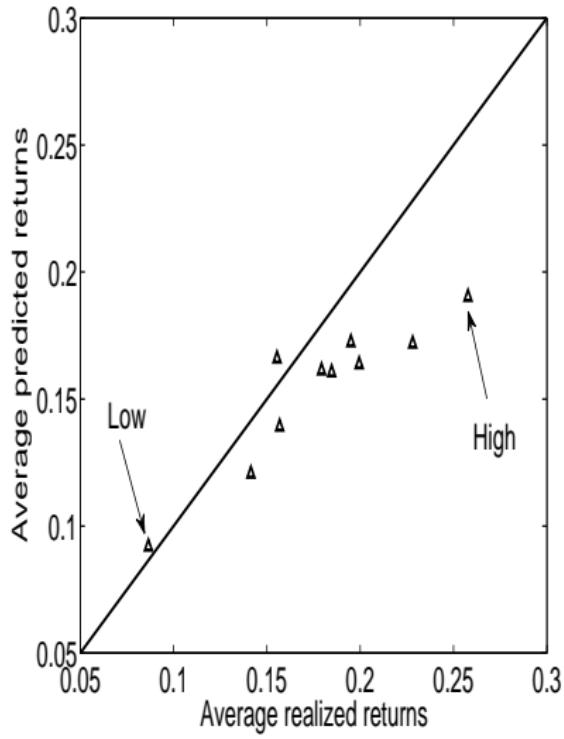
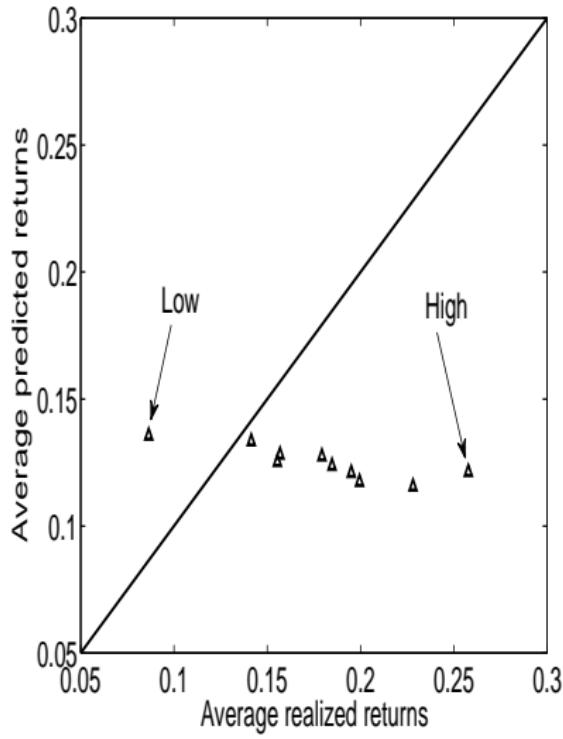
Introduction

Preview: Average predicted vs. realized returns, the SUE deciles,
the consumption CAPM and the investment CAPM



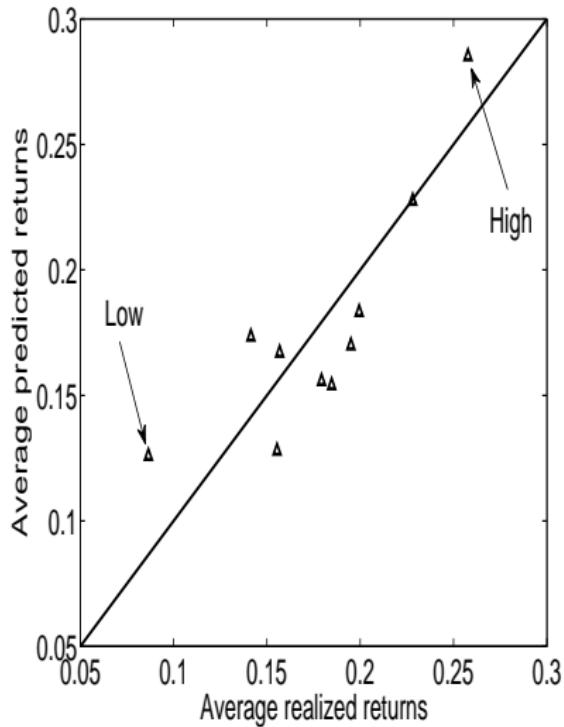
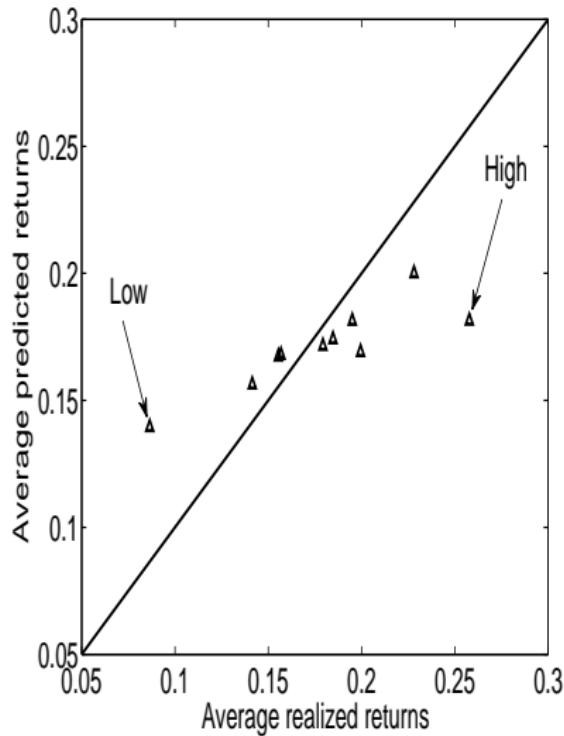
Introduction

Average predicted vs. realized returns, the B/M deciles,
the CAPM and the Fama-French 3-factor model



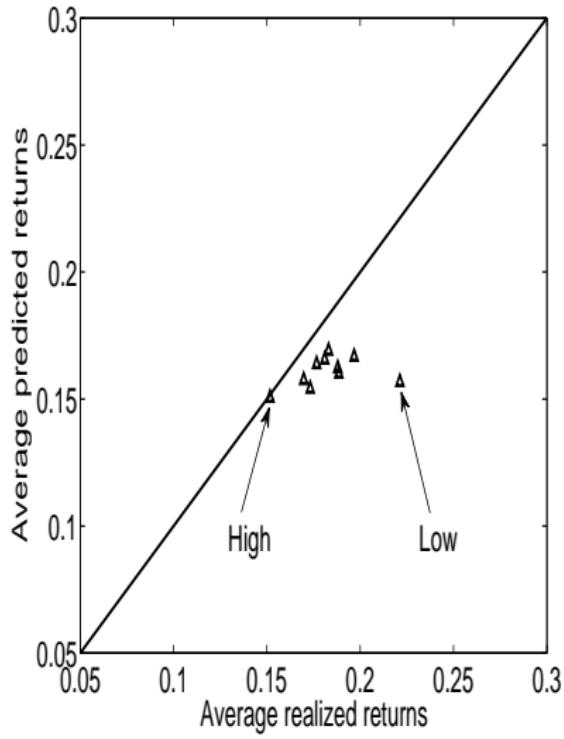
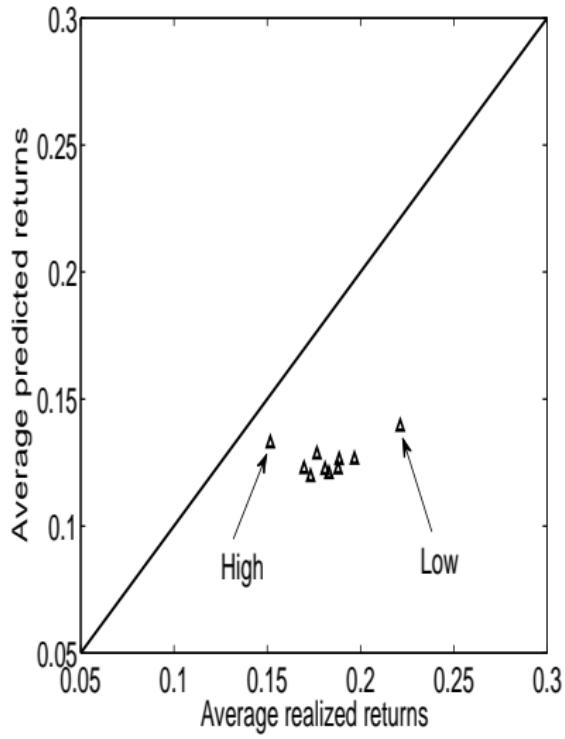
Introduction

Average predicted vs. realized returns, the B/M deciles,
the consumption CAPM and the investment CAPM



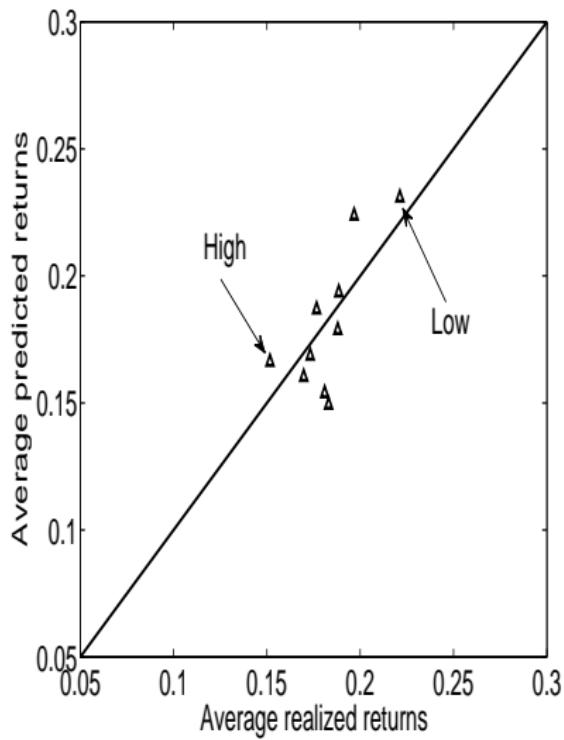
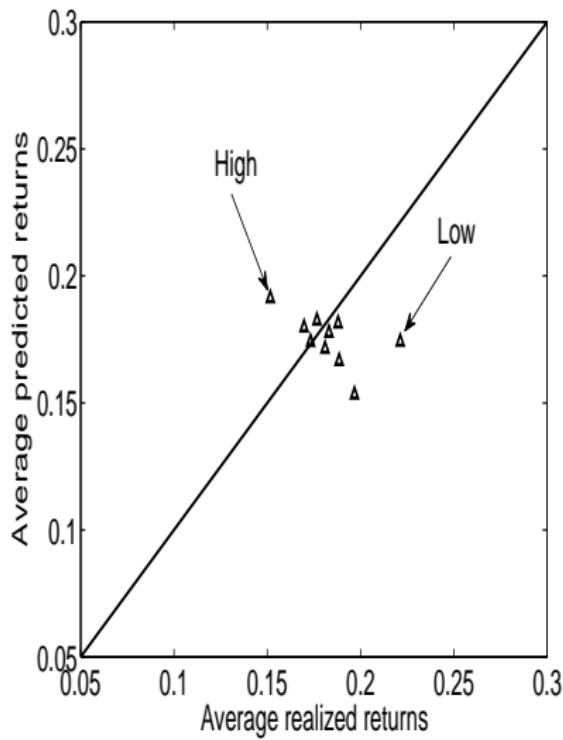
Introduction

Average predicted vs. realized returns, the CI deciles,
the CAPM and the Fama-French 3-factor model



Introduction

Average predicted vs. realized returns, the CI deciles,
the consumption CAPM and the investment CAPM



Outline

- 1 The Model**
- 2 Econometric Methods**
- 3 Matching Expected Stock Returns**
- 4 Matching Expected Returns and Variances**
- 5 Critiques**

Outline

- 1 The Model**
- 2 Econometric Methods
- 3 Matching Expected Stock Returns
- 4 Matching Expected Returns and Variances
- 5 Critiques

Model

The investment CAPM reformulated from the neoclassical q -theory of investment

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:

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

Model

Equity-value maximization

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

Payout, D_{it} , defined as:

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

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

Model

The investment return: A technological, not financial, concept

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

$$r_{it+1}^I \equiv \frac{\overbrace{\left[\begin{array}{c} \text{Marginal benefit of investment at } t+1 \\ (1 - \tau_{t+1}) \left[\alpha \frac{Y_{it+1}}{K_{it+1}} + \frac{a}{2} \left(\frac{I_{it+1}}{K_{it+1}} \right)^2 \right] \end{array} \right]}^{\text{Marginal product plus reduction of } \Phi_{it+1} \text{ (net of taxes)}} + \tau_{t+1} \delta_{it+1} + (1 - \delta_{it+1}) \left[1 + (1 - \tau_{t+1}) a \left(\frac{I_{it+1}}{K_{it+1}} \right) \right]}{\overbrace{\left[\begin{array}{c} \text{Expected continuation value} \\ 1 + (1 - \tau_t) a \left(\frac{I_{it}}{K_{it}} \right) \end{array} \right]}^{\text{Marginal cost of investment at } t}}$$

Model

The weighted average cost of capital

$$E_t [M_{t+1} r_{it+1}^{Ba}] = 1, \text{ in which } r_{it+1}^{Ba} = r_{it+1}^B - (r_{it+1}^B - 1)\tau_{t+1}$$

The stock return: $r_{it+1}^S \equiv (P_{it+1} + D_{it+1})/P_{it}$, with $P_{it} \equiv V_{it} - D_{it}$

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

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

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

Outline

- 1** The Model
- 2** Econometric Methods
- 3** Matching Expected Stock Returns
- 4** Matching Expected Returns and Variances
- 5** Critiques

Econometric Methods

GMM

Expected stock returns = expected levered investment returns?

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

Stock return variances = levered investment return variances?

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

The impact of measurement errors on mean and volatility of returns

Econometric Methods

Testing portfolios

Equal-weighted in the text (value-weighted in the OA):

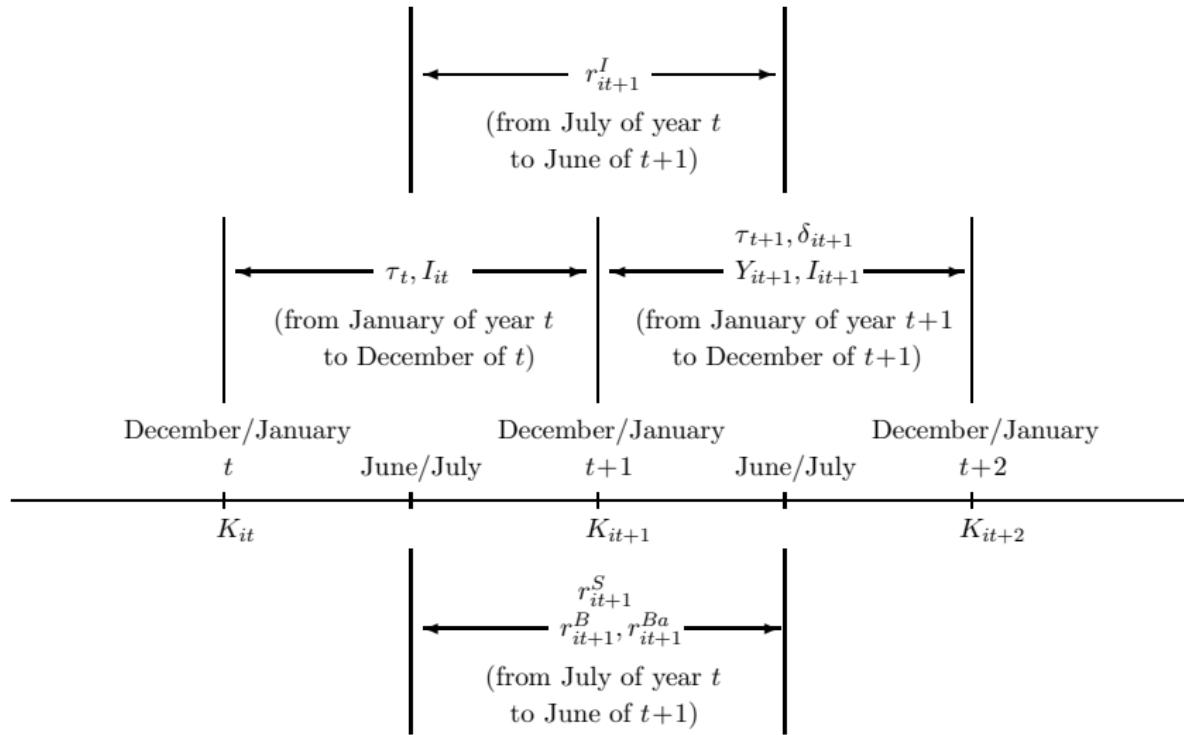
- The Standardized Unexpected Earnings (SUE) deciles (Chan, Jegadeesh, and Lakonishok 1996)
- The book-to-market deciles (Fama and French 1993)
- The corporate investment deciles (Titman, Wei, and Xie 2004)

Why portfolios?

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

Econometric Methods

Timing alignment: Only firms with December fiscal yearend included in the sample



Econometric Methods

Measurement

K_{it} : Gross property, plant, and equipment

I_{it} : Capital expenditure minus sales of PPE

Y_{it} : Sales

B_{it} : Long-term debt plus short-term debt

P_{it} : The market equity from CRSP

δ_{it} : The amount of depreciation divided by capital

r_{it+1}^B : Imputed bond ratings, bond returns assigned to firms with the same rating (Blume, Lim, and MacKinlay 1998)

τ_t : Statutory tax rate of corporate income

Outline

- 1 The Model**
- 2 Econometric Methods**
- 3 Matching Expected Stock Returns**
- 4 Matching Expected Returns and Variances**
- 5 Critiques**

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, the SUE deciles

	Low	5	High	H-L	$[t_{H-L}]$
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, the B/M deciles

	Low	5	High	H-L	$[t_{H-L}]$
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, the CI deciles

	Low	5	High	H-L	$[t_{H-L}]$
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

Expected return “determinants”

The role of Y_{it+1}/K_{it+1} , I_{it+1}/I_{it} , and I_{it}/K_{it} ; w_{it} , δ_{it+1} , and r_{it+1}^B :

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

Expected Stock Returns

Characteristics, the SUE deciles

	Low	5	High	H-L	[t_{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_{it+1}^B	9.44	9.76	9.38	-0.06	[-0.27]

Expected Stock Returns

Comparative statics, the SUE deciles

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

Expected Stock Returns

Characteristics, the B/M deciles

	Low	5	High	H-L	[t_{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_{it+1}^B	8.17	8.09	8.52	0.35	[1.05]

Expected Stock Returns

Comparative statics, the B/M deciles

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

Expected Stock Returns

Characteristics, the CI deciles

	Low	5	High	H-L	[t_{H-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_{it+1}^B	8.47	8.27	8.44	-0.03	[-0.15]

Expected Stock Returns

Comparative statics, the CI deciles

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

Outline

- 1 The Model**
- 2 Econometric Methods**
- 3 Matching Expected Stock Returns**
- 4 Matching Expected Returns and Variances**
- 5 Critiques**

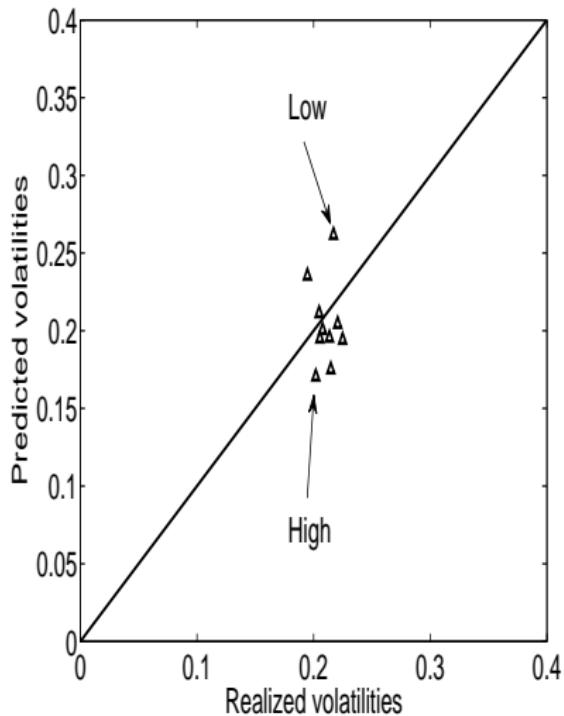
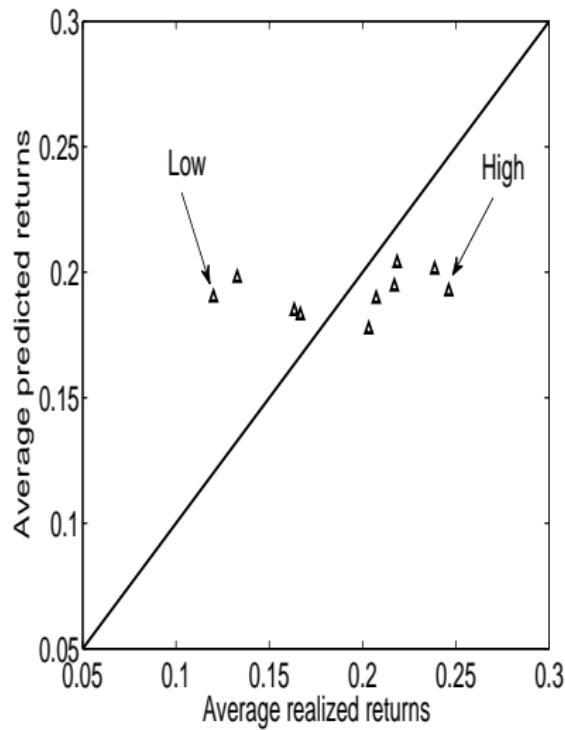
Joint Estimation

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

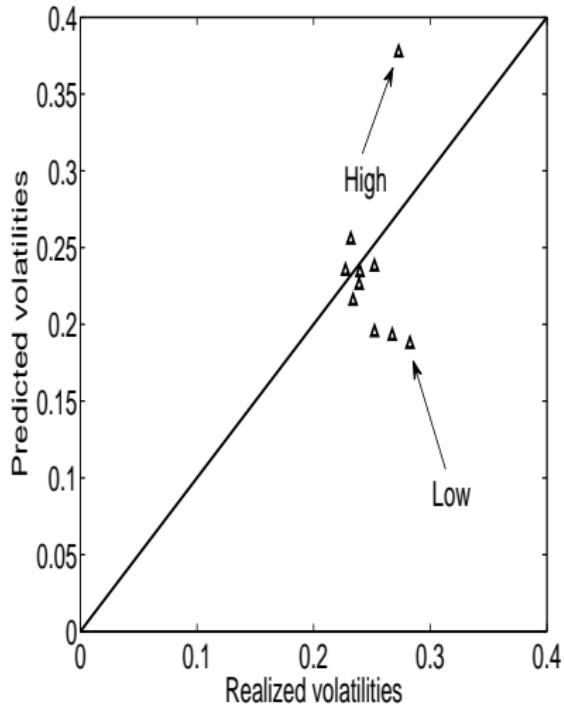
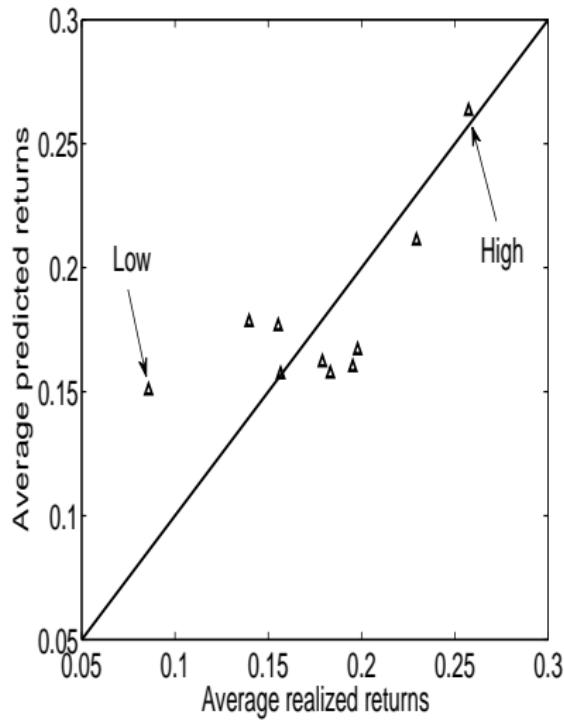
Joint Estimation

Predicted vs. realized stock return means and volatilities, the SUE deciles



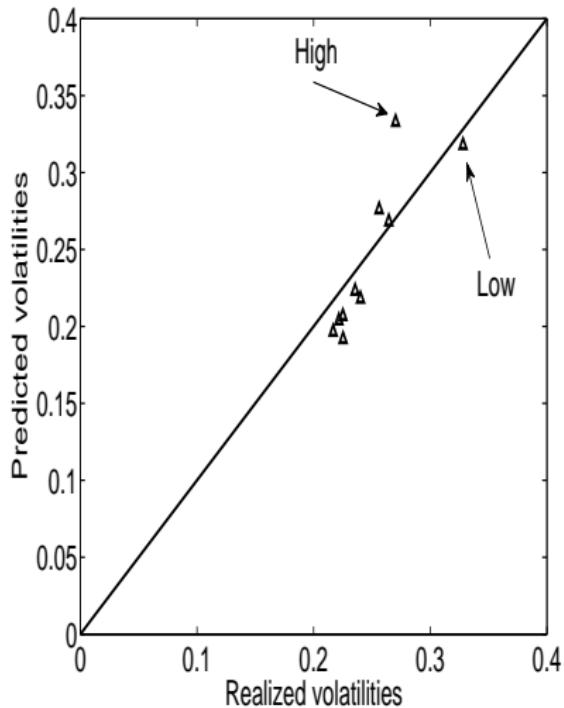
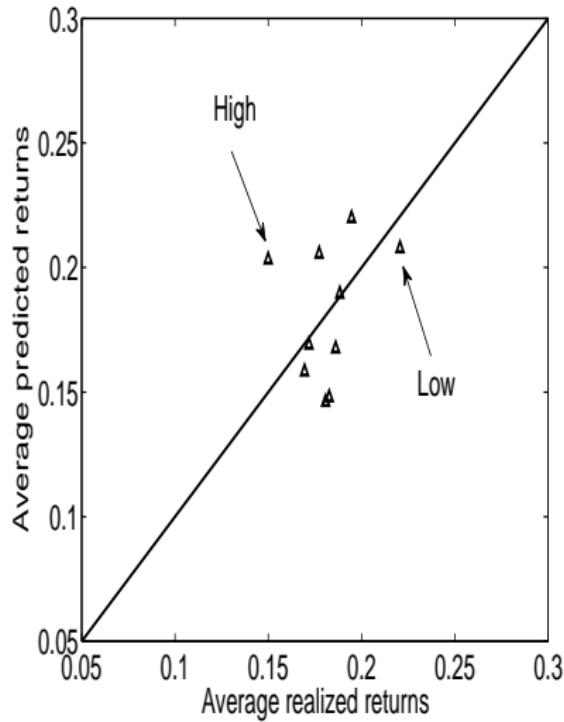
Joint Estimation

Predicted vs. realized stock return means and volatilities, the B/M deciles



Joint Estimation

Predicted vs. realized stock return means and volatilities, the CI deciles



Robustness

The Online Appendix

Second-stage GMM

The market value of debt per Bernanke and Campbell (1988)

Value-weighted returns

Alternative window length in the Bartlett kernel

Capital as PPENT; investment as CAPX

Time-invariant corporate tax rates

Firm-specific corporate tax rates per Graham (1996)

Outline

- 1 The Model
- 2 Econometric Methods
- 3 Matching Expected Stock Returns
- 4 Matching Expected Returns and Variances
- 5 Critiques

Critiques

Parameter instability

The a and α parameter estimates vary with testing portfolios

Equivalently, the failure of jointly explaining value and SUE

Goncalves, Xue, and Zhang (2020):

- Exact aggregation
- Working capital

Critiques

Ex ante versus ex post restrictions

Original (unfortunate?) wording says “weaker” ex ante restriction

The NPV rule does use (ex ante) cost of capital

Measurement errors mess up ex post: Focus on signal, not noise

Potentially explain announcement date returns for anomalies

Critiques

Does the investment CAPM “explain” anomalies?

Still exploring the **scientific explanation** literature in philosophy of science (Hempel 1965; Salmon 1984; Kitcher 1989)

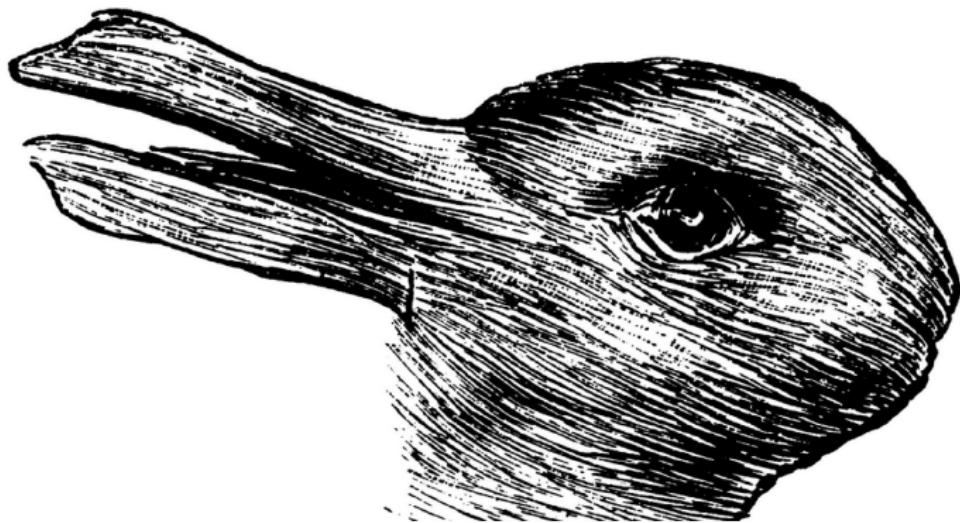
For now, the investment CAPM fits Kitcher’s **unification** account of explanation well

The investment CAPM no more or less “causal” than the consumption CAPM

Covariances versus characteristics: Measurement, not conceptual, issue; both accord with EMH

Critiques

Kuhn's (1962) "gestalt switch" and incommensurability: What animal do you see?
The consumption CAPM anomalies as the investment CAPM regularities?



Conclusion

A first stab at GMMing the investment CAPM

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