Capital Heterogeneity, Time-To-Build, and Return Predictability

Discussion

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Aims

- A investment-based asset pricing paper

- Connect returns on investments to stock market returns.

Why do we care?

- Would like to relate asset returns to fundamentals – look at investment instead of consumption (Cochrane (1991))
- Full blown GE model should feature consumption and investment – so investment view of asset prices just as important as consumption view.

Outline of Paper

- Empirics: Which investment rates predict returns?
  - investment rate
$$IK_t = \frac{I_t}{I_{t-1}} \frac{IK_{t-1}}{1-\delta IK_{t-1}}$$
  - look at equipment and structures separately for US aggregate and US industry, and UK aggregate data
  - split each of equipment and structures into types
  - check predictability of aggregate and industry excess returns
$$\underbrace{\sum_{h=1}^{H} R_{t+h}}_{H\text{-period cumulated log excess return}} = a + bIK_t + \epsilon_{t+H} \quad (1)$$
- Main finding: stronger power of equipment investment relative to structures investment for predicting excess returns and the lagging behavior of structures investment relative to total factor productivity
- Model: build GE model of rep firm and rep household with **time to build**
$$K_{i,t+1} = (1-\delta_i)K_{i,t} + X_{i,t-J_i+1} \; i \in \{e, s\} \quad (2)$$
  - J_i is time to build for investment of type $i \in \{e, s\}$
- $1 = J_e < J_s = 5$

Investment Rates	H	In Sample			Out of Sample	
		$R^2\%$	b	$p(NW)$	$R^2\%$	ENC-NEW
Nonresidential	1	3.90	-6.48	0.002	0.68	3.242***
	4	11.24	-22.55	0.001	6.31	4.414***
	8	18.45	-39.39	0.000	15.52	5.079***
	12	29.02	-57.63	0.000	26.68	7.170***
	16	38.08	-73.34	0.000	33.98	9.340***
	20	39.26	-85.80	0.000	26.99	8.931***
Equipment	1	3.04	-2.93	0.005	-1.14	1.321*
	4	9.26	-10.45	0.003	1.10	2.196**
	8	15.52	-18.40	0.002	7.26	2.578**
	12	25.50	-27.38	0.000	18.48	4.351***
	16	35.16	-35.54	0.000	32.22	7.397***
	20	39.06	-42.57	0.000	34.73	9.520***
Structures	1	0.97	-3.19	0.091	-2.55	0.462
	4	2.42	-10.40	0.068	-6.47	0.099
	8	3.99	-18.43	0.051	-12.22	0.179
	12	6.44	-27.74	0.053	-26.44	0.326
	16	8.46	-35.97	0.087	-50.93	0.328
	20	7.83	-40.75	0.159	-87.25	0.063

Model

- Representative firm

$$Y_t = F(K_{e,t}, K_{s,t}, L_t) = A_t K_{e,t}^{\alpha_e} K_{s,t}^{\alpha_s} (Z_t L_t)^{1-\alpha_e-\alpha_s} \tag{3}$$

$$D_t = Y_t - I_{e,t} - I_{s,t} - \underbrace{G_{e,t}}_{\text{e cost function}} - \underbrace{G_{s,t}}_{\text{s cost function}} - W_t L_t \tag{4}$$

- Bellman equation

$$V_t = \sup_{\{K_{e,t+J_e+1}, X_{e,t+j}, K_{s,t+J_s+1}, X_{s,t+j}\}_{j=0}^{\infty}} D_t + E_t \left[\frac{M_{t+1}}{M_t} V_{t+1} \right] \tag{5}$$

subject to capital accumulation equations with time to build

- Representative Household – Campbell-Cochrane Habit

Investment returns and stock returns

- With no adjustment costs and no time to build

$$\underbrace{R_{I,t}}_{\text{investment return}} = \underbrace{R_{m,t}}_{\text{stock market return}} \tag{6}$$

- With adjustment costs and time to build

$$R_{I,t} \neq R_{m,t} \tag{7}$$

- $R_{I,t}$ has two components, $\underbrace{R_{e,t}}_{\text{eq. inv return}}$ and $\underbrace{R_{s,t}}_{\text{struc. inv return}}$
- $J_e < J_s \Rightarrow R_{e,t}$ closer to $R_{m,t}$

Predictive Regressions	H	Data		Model Benchmark		Model 1 Same δ $\bar{\delta} = 0.025$		Model 2 Same α $\alpha = 0.18$		Model 3 No TTB $J = 1$	
		$R^2\%$	b	$R^2\%$	b	$R^2\%$	b	$R^2\%$	b	$R^2\%$	b
Equipment	1	2.7	-2.8	7.2	-8.2	3.6	-4.3	8.6	-9.7	1.2	-1.7
Predicts	4	7.9	-9.8	20.9	-24.2	11.1	-13.4	24.6	-28.0	4.8	-6.6
R_m	12	21.0	-25.6	23.7	-30.0	17.9	-23.2	26.1	-32.2	13.1	-18.7
	20	33.1	-41.4	27.9	-37.2	24.1	-32.5	29.8	-38.6	20.0	-29.4
Equipment	1	3.0	-2.9	0.6	-1.8	0.7	-1.6	0.6	-1.8	0.7	-1.1
Predicts	4	9.3	-10.4	2.1	-6.9	2.6	-6.0	2.0	-6.8	2.7	-4.4
$R_m - R_f$	12	25.5	-27.4	5.5	-19.2	7.0	-16.5	5.0	-19.2	7.6	-12.1
	20	39.1	-42.6	8.8	-30.3	11.2	-25.8	8.0	-30.6	11.9	-18.7
Equipment	1	0.7	0.1	35.9	-6.4	30.7	-2.7	38.3	-7.9	35.4	-0.6
Predicts	4	2.0	0.7	32.9	-17.3	25.5	-7.5	35.9	-21.1	35.5	-2.3
R_f	12	2.5	1.8	5.9	-10.8	9.7	-6.7	6.0	-13.0	35.3	-6.6
	20	0.5	1.2	4.0	-6.9	9.9	-6.7	3.7	-8.1	34.9	-10.6
Structures	1	0.6	-2.4	1.1	-3.6	1.2	-2.6	1.1	-4.0	1.5	-1.7
Predicts	4	1.2	-7.3	2.6	-9.0	3.5	-7.9	2.2	-9.4	5.6	-6.7
R_m	12	3.0	-19.5	9.2	-19.8	11.0	-19.3	8.1	-20.0	15.5	-18.8
	20	3.7	-29.5	15.2	-29.1	17.2	-29.2	13.5	-29.1	23.6	-29.5
Structures	1	1.0	-3.2	0.8	-2.7	0.7	-1.8	0.9	-3.1	0.8	-1.2
Predicts	4	2.4	-10.4	3.2	-10.5	2.7	-6.9	3.3	-11.9	3.1	-4.5
$R_m - R_f$	12	6.4	-27.7	9.0	-29.3	7.7	-19.2	9.1	-33.3	8.8	-12.5
	20	7.8	-40.8	13.8	-44.8	11.9	-29.4	13.9	-51.0	13.8	-19.4
Structures	1	6.1	0.8	1.0	-0.8	4.0	-0.9	0.8	-0.9	40.2	-0.6
Predicts	4	10.6	3.1	1.1	1.5	3.4	-1.0	1.1	2.5	40.3	-2.2
R_f	12	13.1	8.2	5.1	9.4	7.0	-0.1	5.5	13.2	39.8	-6.3
	20	10.0	11.2	8.7	15.6	10.2	0.2	9.3	21.8	39.0	-10.1

Exploit industry cross-section

Table 7: Return Predictability from Industry Investment Rates at 5-year Horizon

This table reports in-sample R^2 (in percent) for OLS predictions of US aggregate risk premium (Panel A) and of US 14 sectoral risk premium (Panel B) from 1962 to 2015 at a 5-year horizon, $\sum_{h=1}^{5} R_{t+h} = a + b\,\text{IK}_t + \varepsilon_{t+5}$. Predictor variables are each industry's investment rates of equipment and structures. b denotes the prediction slope coefficient. $p(NW)$ denotes in-sample p-values constructed as in Newey and West (1987). The last column shows the difference in R^2 between equipment and structures.

Industry	Equipment			Structures			ΔR^2
	$R^2\%$	b	$p(NW)$	$R^2\%$	b	$p(NW)$	E-S
Panel A: How Does Industry IK Predict **Aggregate** Risk Premium?							
Agriculture	7.25	-3.12	0.031	1.99	-6.03	0.184	5.27
Mining	0.12	-0.26	0.770	5.09	2.81	0.174	-4.97
Construction	14.32	-2.48	0.005	4.74	-1.58	0.259	9.57
Manufacturing	17.90	-7.01	0.003	11.96	-8.77	0.087	5.94
Wholesale	19.94	-3.19	0.001	0.26	-0.52	0.758	19.68
Retail	17.52	-5.07	0.000	9.30	-6.91	0.046	8.22
Transp & warehousing	20.95	-6.75	0.000	0.50	3.45	0.733	20.45
Information	18.23	-5.41	0.002	16.11	-11.21	0.029	2.12
Profes, scient & techn serv	6.04	-1.59	0.058	0.15	-0.38	0.829	5.89

Structures: Wholesale, transport and investment – why such high R^2? Is time to build less? If so, provides support for main channel of model.

Excess returns v returns v risk-free rate

Predictive Regressions	H	Data		Model Benchmark		Model 1 Same δ $\bar{\delta}=0.025$		Model 2 Same α $\alpha=0.18$		Model 3 No TTB $J=1$	
		$R^2\%$	b	$R^2\%$	b	$R^2\%$	b	$R^2\%$	b	$R^2\%$	b
Equipment	1	2.7	-2.8	7.2	-8.2	3.6	-4.3	8.6	-9.7	1.2	-1.7
Predicts	4	7.9	-9.8	20.9	-24.2	11.1	-13.4	24.6	-28.0	4.8	-6.6
R_m	12	21.0	-25.6	23.7	-30.0	17.9	-23.2	26.1	-32.2	13.1	-18.7
	20	33.1	-41.4	27.9	-37.2	24.1	-32.5	29.8	-38.6	20.0	-29.4
Equipment	1	3.0	-2.9	0.6	-1.8	0.7	-1.6	0.6	-1.8	0.7	-1.1
Predicts	4	9.3	-10.4	2.1	-6.9	2.6	-6.0	2.0	-6.8	2.7	-4.4
$R_m - R_f$	12	25.5	-27.4	5.5	-19.2	7.0	-16.5	5.0	-19.2	7.6	-12.1
	20	39.1	-42.6	8.8	-30.3	11.2	-25.8	8.0	-30.6	11.9	-18.7
Equipment	1	0.7	0.1	35.9	-6.4	30.7	-2.7	38.3	-7.9	35.4	-0.6
Predicts	4	2.0	0.7	32.9	-17.3	25.5	-7.5	35.9	-21.1	35.5	-2.3
R_f	12	2.5	1.8	5.9	-10.8	9.7	-6.7	6.0	-13.0	35.3	-6.6
	20	0.5	1.2	4.0	-6.9	9.9	-6.7	3.7	-8.1	34.9	-10.6
Structures	1	0.6	-2.4	1.1	-3.6	1.2	-2.6	1.1	-4.0	1.5	-1.7
Predicts	4	1.2	-7.3	2.6	-9.0	3.5	-7.9	2.2	-9.4	5.6	-6.7
R_m	12	3.0	-19.5	9.2	-19.8	11.0	-19.3	8.1	-20.0	15.5	-18.8
	20	3.7	-29.5	15.2	-29.1	17.2	-29.2	13.5	-29.1	23.6	-29.5
Structures	1	1.0	-3.2	0.8	-2.7	0.7	-1.8	0.9	-3.1	0.8	-1.2
Predicts	4	2.4	-10.4	3.2	-10.5	2.7	-6.9	3.3	-11.9	3.1	-4.5
$R_m - R_f$	12	6.4	-27.7	9.0	-29.3	7.7	-19.2	9.1	-33.3	8.8	-12.5
	20	7.8	-40.8	13.8	-44.8	11.9	-29.4	13.9	-51.0	13.8	-19.4
Structures	1	6.1	0.8	1.0	-0.8	4.0	-0.9	0.8	-0.9	40.2	-0.6
Predicts	4	10.6	3.1	1.1	1.5	3.4	-1.0	1.1	2.5	40.3	-2.2
R_f	12	13.1	8.2	5.1	9.4	7.0	-0.1	5.5	13.2	39.8	-6.3
	20	10.0	11.2	8.7	15.6	10.2	0.2	9.3	21.8	39.0	-10.1

- This is a problem
- What is time to build resolving: predictability of excess returns, returns or risk-free rate, and at which horizon?

TTB and Predictability

- Expenditures
  - R_m
    - Short-horizon predictability matches data less well with TTB
    - Long-horizon predictability matches data better with TTB
  - $R_m - R_f$
    - Predictability R^2 change very little with TTB
  - R_f
    - Short-horizon predictability same (R^2 too high!) with TTB
    - Long-horizon predictability matches data better (R^2 reduced) with TTB
- Structures
  - R_m
    - Predictability does not change much (R^2 too high at long horizons) with TTB
  - $R_m - R_f$
    - Predictability R^2 change very little with TTB
  - R_f
    - Predictability greatly reduced at all horizons TTB
    - Reduction is too much relative to data – particularly at shorter horizons
- Most of the action is in the predictability of the risk-free rate
- What is the economic intuition?

TTB and Predictability II - A Different SDF

- The impact of introducing TTB on the pricing of risk and time discounting at different horizons is not what you would want based on the data.
- I suggest using a different SDF – perhaps from an EZW rep agent.

Lars Kuehn's paper

- Adlai Fisher probably honed in on this – seems like you have rewritten accordingly
- help yourself – exploit the industry cross-section!
- Is the impact of TTB on the predictability of the risk-free rate similar in Kuehn (2007)?

Summary

- Nice intuition – gap between investment returns and stock returns impacted by TTB
- TTB lower for equipment v structures $\Rightarrow$ equipment investment better predictor for returns than structures

- Exploit industry cross-section – supportive of channel
- Most of the action from TTB is in the predictability of the risk-free rate – seems at odds with data. Use a different set of preferences for household?