Does Costly Reversibility Matter for U.S. Public Firms?

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Theme

Costly reversibility matters for U.S. public firms

Outline

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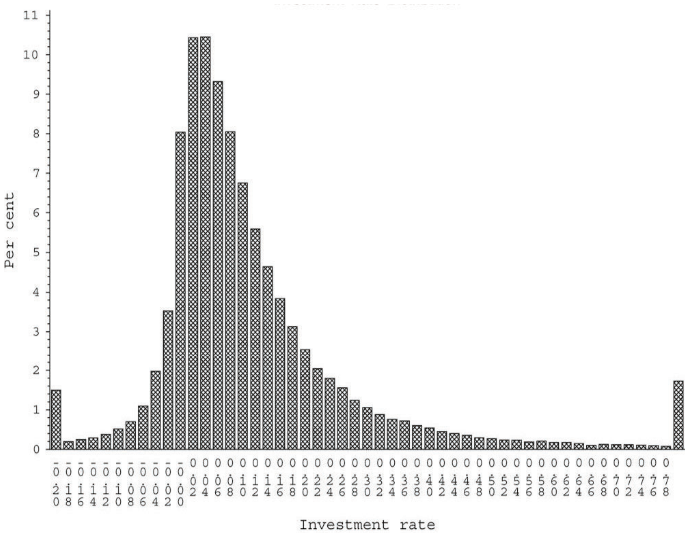
Costly reversibility reduces negative investments and raises the hurdle for positive investments:

- Arrow (1968), Abel (1983), Bernanke (1983), McDonald and Siegel (1986), Abel and Eberly (1994, 1996), Dixit and Pindyck (1994), Abel, Dixit, Eberly, and Pindyck (1996)

Costly reversibility and operating leverage help explain the value premium in the cross section of equity returns:

- Carlson, Fisher, and Giammarino (2004), Zhang (2005), Cooper (2006)

Prior plant-level evidence on costly reversibility in Cooper and Haltiwanger (2006)



"It is transparent that the investment rate distribution is non-normal having a considerable mass around 0, fat tails, and is highly skewed to the right" (p. 614)

"a key feature of the micro-data: investment rates are highly asymmetric" (p. 614)

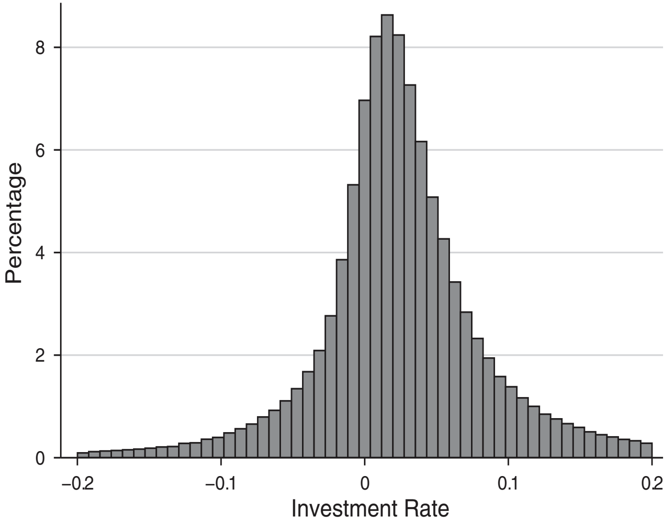
"This striking asymmetry between positive and negative investment is an important feature of the data that our analysis seeks to match" (p. 614)

"the investment distribution at the micro-level is very asymmetric and has a fail right tail" (p. 616)

"the more robust finding . . . is that the distribution of investment is skewed and kurtotic with a fat right tail" (p. 616)

Introduction

Clementi and Palazzo (2019): Compustat I/K, 1978:Q1–2016:Q4



Clementi and Palazzo (2019, p. 282):
"We start by documenting investment behavior among publicly traded U.S. firms... akin to that conducted by Cooper and Haltiwanger (2006) on manufacturing plants."

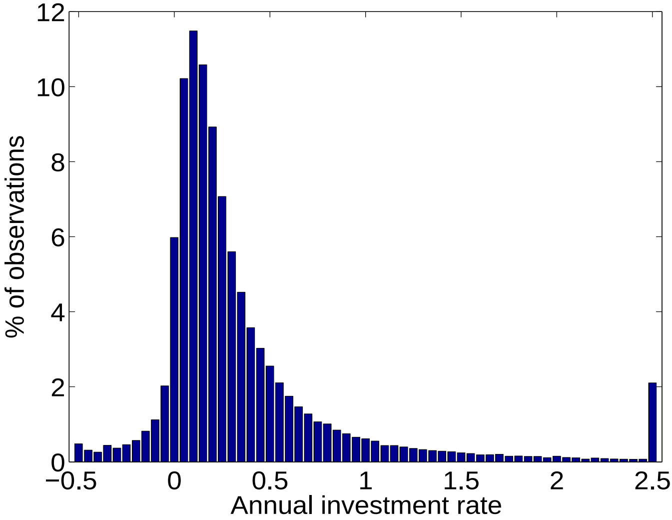
"each quarter on average 18.2% of firms record negative gross investment... strong evidence against the assumption of irreversibility" (p. 282)

"capital accumulation at public firms is likely to be very different from that emerging from the analysis of a representative sample of manufacturing establishments... our study emphasizes features, such as the volatility and reversibility of investment" (p. 285)

"18% of firms have an investment rate lower than -1%. It turns out that plenty of firms downsize, at all times" (p. 287)

"for U.S. public firms, investment displays substantial volatility and no sign of irreversibility (p. 289, our emphasis)"

1962–2018, annual I/K distribution in Compustat, 175,025 firm-years, 5.79% (below −1%), 1.46% (between −1% and 1%), and 92.75% (above 1%)



The firm-level I/K distribution in Compustat is highly skewed to the right, with a small fraction of negative investment, 5.79%, and a large fraction of positive investment, 92.75%

The standard investment model explains the average value premium, while simultaneously matching the volatility and skewness of firm-level investment rates in SMM

Gross investment rate (net investment rate + depreciation rate):

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

in which

- I_{it}: Gross investment
- K_{it}: Capital as net PPE (item PPENT)
- δ_{it}: Depreciation rate (item DP minus AM, scaled by PPENT)

Net PPE (K_{it}) = Gross PPE $\left(K_{i0} + \sum_{s=0}^{t-1} I_{is}\right)$ minus cumulative depreciation expenses $\left(\sum_{s=0}^{t-1} \delta_{is} K_{is}\right)$

The I/K Distribution

Averages of cross-sectional moments of annual I/K, 1962–2018, 175,025 firm-years

Gross investment rates

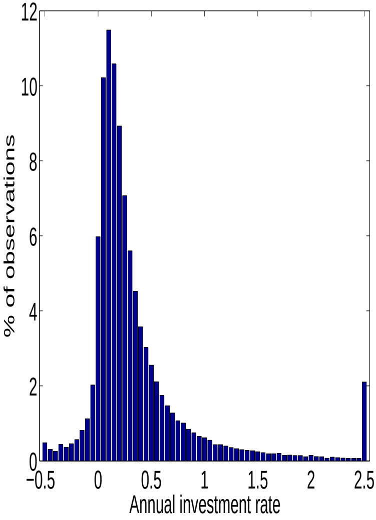
	Mean	Std	Skew	Kurt	5th	25th	50th	75th	95th	ρ_1	$\%_I^-$	$\%_I^0$
Est	38.41	58.48	3.44	15.58	−3.65	11.00	22.43	43.71	132.93	25.52	5.79	1.46
Ste	2.01	4.58	0.12	0.96	0.82	0.34	0.76	2.04	8.60	0.78	0.35	0.08

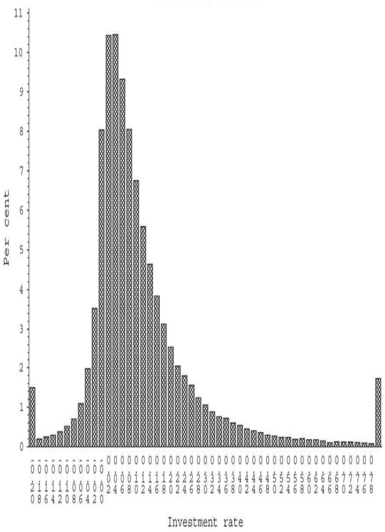
(CAPX − SPPE)/PPENT

	Mean	Std	Skew	Kurt	5th	25th	50th	75th	95th	ρ_1	$\%_I^-$	$\%_I^0$
Est	31.48	37.51	3.05	12.17	2.65	11.55	20.57	36.82	97.90	39.02	2.03	1.30
Ste	1.10	2.41	0.10	0.75	0.33	0.33	0.49	1.14	4.82	1.10	0.24	0.11

The I/K Distribution

Firm-level versus plant-level (Cooper and Haltiwanger 2006)





The I/K Distribution

Firm-level versus plant-level (Cooper and Haltiwanger 2006)

Negative I/K: 5.79% versus 10.4%

Inactive I/K: 1.46% versus 8.1%

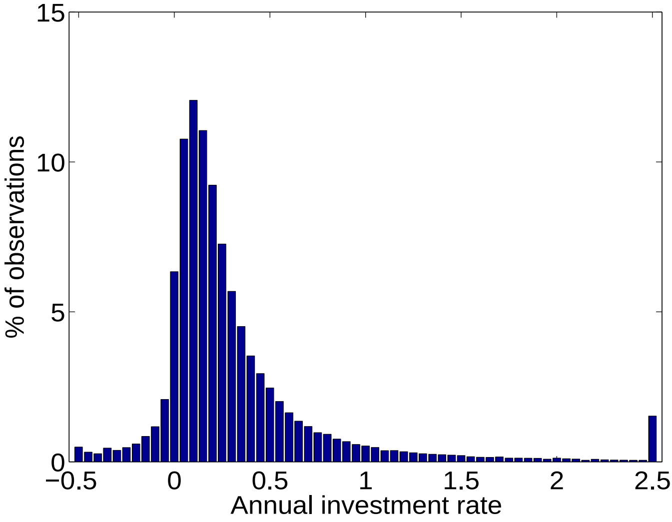
Autocorrelation of I/K: 25.5% versus 5.8%

Sample differences:

- Compustat firms, not restricting size, age, or industry
- A balanced panel with ≈7,000 large manufacturing plants in continuous 1972–1988 operation

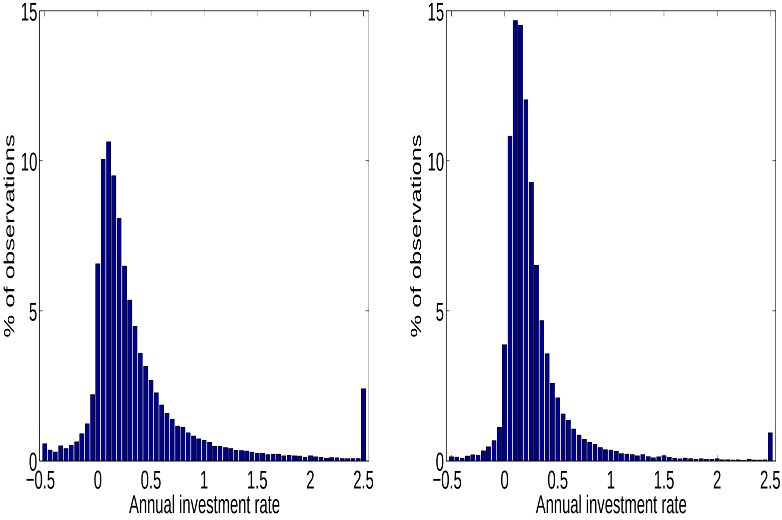
The I/K Distribution

Robustness: Excluding firm-years with large M&As, with the target's book assets above 15% of the acquirer's, only 5.9% of firm-years from the full sample



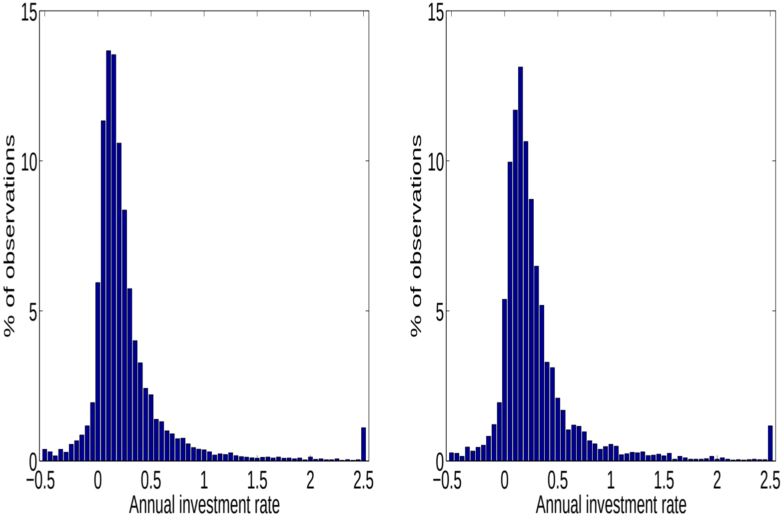
The I/K Distribution

Robustness: Small firms (134,937 firm-years) versus big firms (37,936 firm-years)



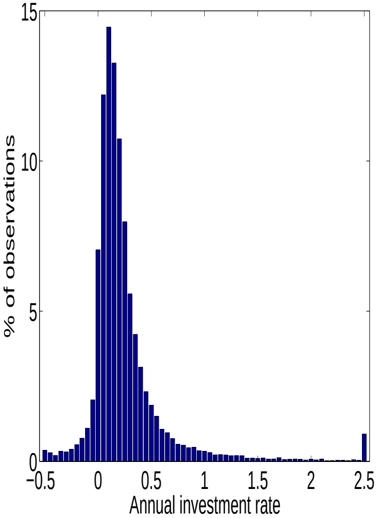
The I/K Distribution

Robustness: Ten industries, NoDur (15,279 firm-years) and Durbl (6,690 firm-years)



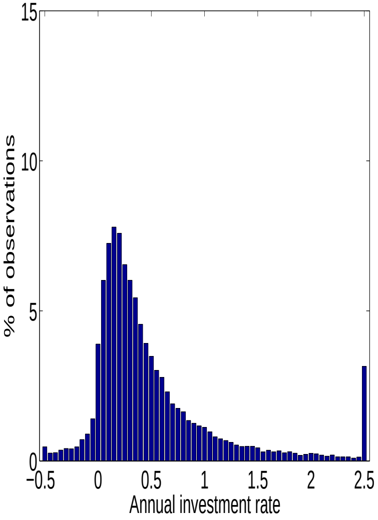
The I/K Distribution

Robustness: Ten industries, Manuf (34,298 firm-years) and Enrgy (8,779 firm-years)



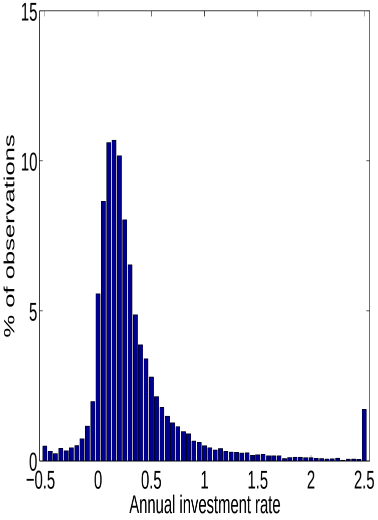
The I/K Distribution

Robustness: Ten industries, HiTec (33,251 firm-years) and Telcm (3,937 firm-years)

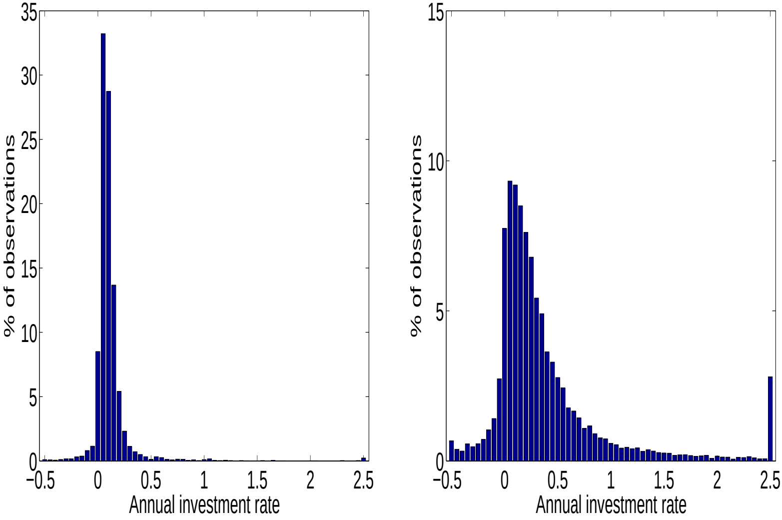


The I/K Distribution

Robustness: Ten industries, Shops (22,081 firm-years) and Hlth (15,987 firm-years)



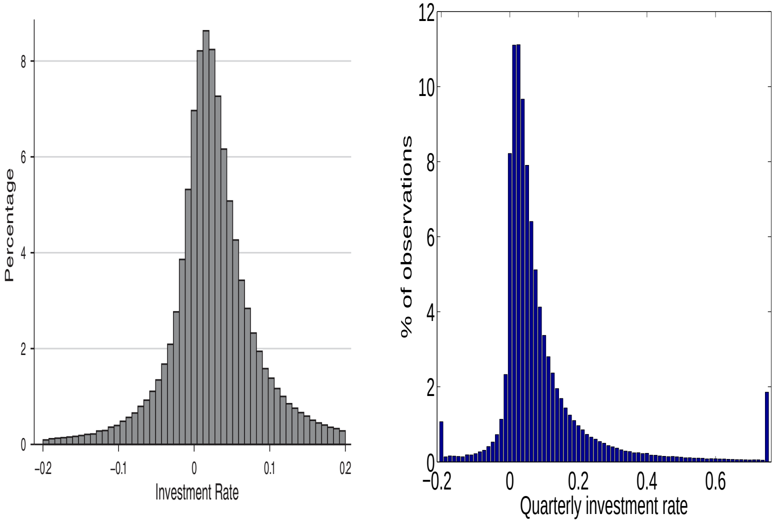
Robustness: Ten industries, Utils (7,951 firm-years) and Other (22,958 firm-years)



Outline

Replication

Quarterly I/K distribution, 1978:Q1–2016:Q4,
Clementi and Palazzo versus our replication, $I/K < -1\%$: 18.2% versus 5.96%



A data error: Clementi and Palazzo's net investment rates internally incompatible with depreciation rates

Nonstandard sample criteria restricting the right tail of the I/K distribution (eliminating a substantial number of M&A firm-years with a 5% [instead of 15%] cutoff)

A highly questionable research practice of cutting off the right tail of the quarterly I/K distribution at 0.2

Clementi and Palazzo's gross I/K conceptually close to ours:

$$\frac{I_{it}}{K_{it}} = \frac{\text{PPENTQ}_{it+1} - \text{PPENTQ}_{it}}{\text{PPENTQ}_{it}} + \delta_i$$

in which PPENTQ is quarterly Compustat net PPE

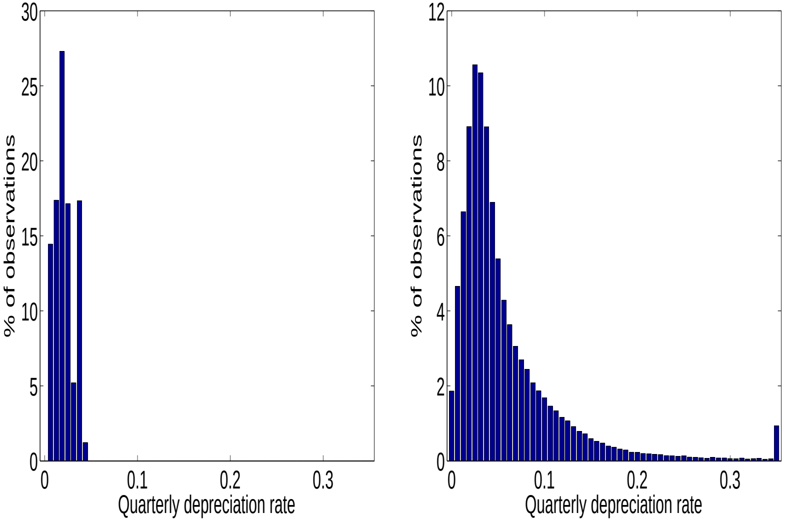
We measure δ_{it} with Compustat quarterly files

Clementi and Palazzo use average industry geometric δ_i from BEA

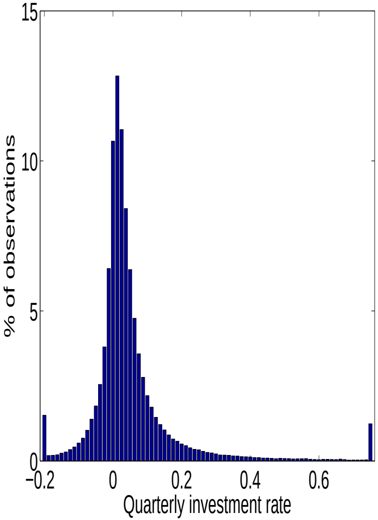
However, Compustat net PPE embeds accounting δ_{it} via perpetual inventory method: net PPE and δ_i not independent from each other

Replication

Quarterly BEA industry versus Compustat firm-level δ_{it}, 1978:Q1–2016:Q4



Replicating Clementi and Palazzo with BEA's δ_i. Replication sample: 463,426 firm-quarters; reproduction sample: 295,155, close to their 296,218



(i) Excluding financial firms, utilities, and unclassified firms (SIC codes $\geq$ 9000);

(ii) dropping firms with fewer than 12 past quarterly investment rates (i.e., dropping the first 12 quarterly investment rate observations);

(iii) dropping firm-quarter observations associated with acquisitions larger than 5% of total assets;

(iv) discarding firm-quarter observations in the top and bottom 0.5% of the pooled distribution of quarterly investment rates; and

(v) dropping firm-quarter observations with missing values of investment rates or book-to-market

The only way to reproduce their Figure 1 is to cut off the right tail at 0.2, a procedure not reported in their paper, but later confirmed by us after requesting and obtaining their Stata code

In our view, this research practice is highly questionable

Clementi and Palazzo conclude "no sign of irreversibility (p. 289)"

Yet a long right tail of the I/K distribution is the "smoking gun" evidence on costly reversibility repeatedly highlighted by Cooper and Haltiwanger (2006)

Even though Clementi and Palazzo claim to perform for public firms empirical work "akin to that conducted by Cooper and Haltiwanger (2006) on manufacturing plants" (p. 282)

$$
\begin{aligned}
V(K_{it}, X_t, Z_{it}) &= \\
\max_{\{\chi_{it}\}} \left(\max_{\{I_{it}\}} \Pi_{it} - I_{it} - H(I_{it}, K_{it}) + E_t \left[M_{t+1} V(K_{it+1}, X_{t+1}, Z_{it+1}) \right], 0 \right) \\
\Pi_{it} &= \Pi(K_{it}, Z_{it}, X_t) = X_t Z_{it} K_{it}^{\alpha} - f \\
x_{t+1} &= \overline{x}(1 - \rho_x) + \rho_x x_t + \sigma_x \epsilon_{t+1}^{x} \\
z_{it+1} &= \rho_z z_{it} + \sigma_z \epsilon_{it+1}^{z} \\
K_{it+1} &= I_{it} + (1 - \delta) K_{it} \\
H(I_{it}, K_{it}) &= \frac{\theta_t}{2} \left(\frac{I_{it}}{K_{it}} \right)^2 K_{it} \\
M_{t+1} &= \beta e^{[\gamma_0 + \gamma_1 (x_t - \overline{x})](x_t - x_{t+1})}
\end{aligned}
$$

Despite its simplicity, the fully specified model still has 14 parameters, $\{\beta,\ \gamma_0,\ \gamma_1,\ \alpha,\ \overline{x},\ \rho_x,\ \sigma_x,\ \delta,\ \widetilde{R},\ \rho_z,\ \sigma_z,\ f,\ c^+,\ c^-\}$

As in Bloom (2009), calibrate a set of predetermined parameters (10) and estimate the key ones (4) via SMM

β	γ_0	γ_1	α	$\overline{x}$	ρ_x	σ_x	δ	$\widetilde{R}$	ρ_z
.9999	17	-1000	.7	-3.18	.983	.0041	.2/12	-12.33%	.97

Estimate 4 parameters, $\mathbf{c} \equiv (\sigma_z, f, \theta^+, \theta^-)$, to match seven data moments, including:

- 4 annual I/K moments (the cross-sectional volatility, 58.48%; skewness, 3.44; autocorrelation, 25.46%; and the fraction of negative investment rates, 5.79%)
- 3 return moments (the average value premium, 0.43% per month; the cross-sectional volatility, 54.26%, and skewness, 1.38, of annual stock excess returns)

VFI on discrete state space

SMM parameters:
$S = 500$, $N = 5000$, $T = 57 \times 12 = 684$, $b = 300$

Panel A: Parameter estimates					Panel B: The χ^2 test		
	θ^+	θ^-	f	σ_z	χ^2	d.f.	p-value
Estimate	0.6312	508.1751	0.0637	0.1580	1.9306	3	0.5869
t-value	4.5978	13.3923	4.2412	8.0705			

Panel C: Individual moments and the significance of their model errors							
	Gross investment rates				Returns		
	Std	Skew	ρ_1	$\%_I^-$	Std	Skew	$\overline{R}_{\mathrm{H-L}}$
Data	0.5848	3.4385	0.2546	0.0579	0.5426	1.3836	0.4289
Model	0.6199	3.3448	0.2653	0.0578	0.5641	1.3581	0.4269
t(Diff)	−1.39	0.94	−1.37	4.50	−1.01	0.42	0.74

Costly reversibility matters for U.S. public firms