Asymmetric Investment Rates

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How to measure the firm-level (fixed) investment rate?

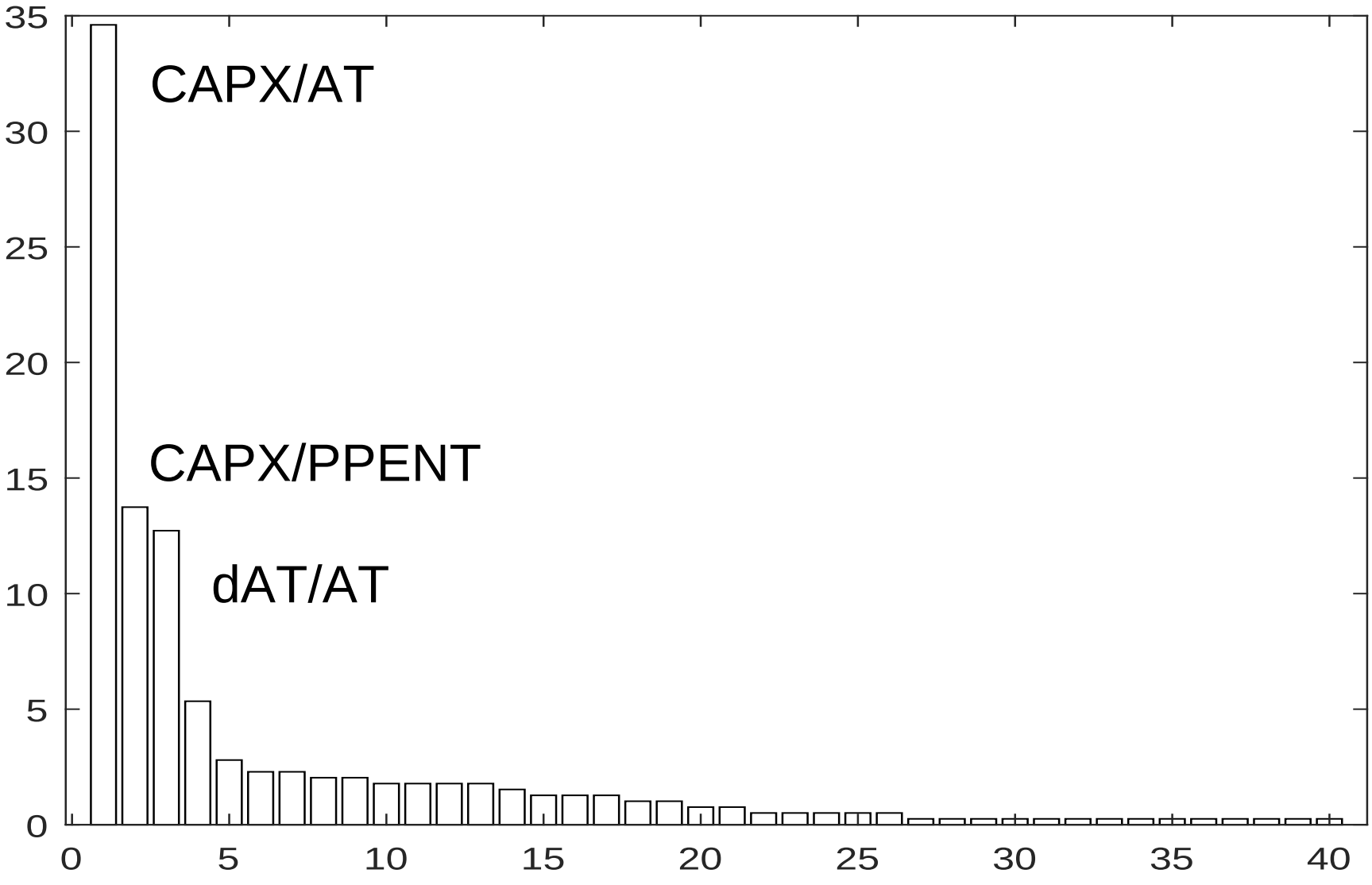
- Building the data infrastructure of firm-specific current-cost capital stocks for the entire Compustat universe

What are the basic properties of the firm-level investment rate?

- Characterizing accurately the key properties, including its asymmetry and lumpiness

Why?

The frequency distribution of 40 investment rates from a meta-study of 347 articles with 393 appearances from 2000 onward in top-five finance journals



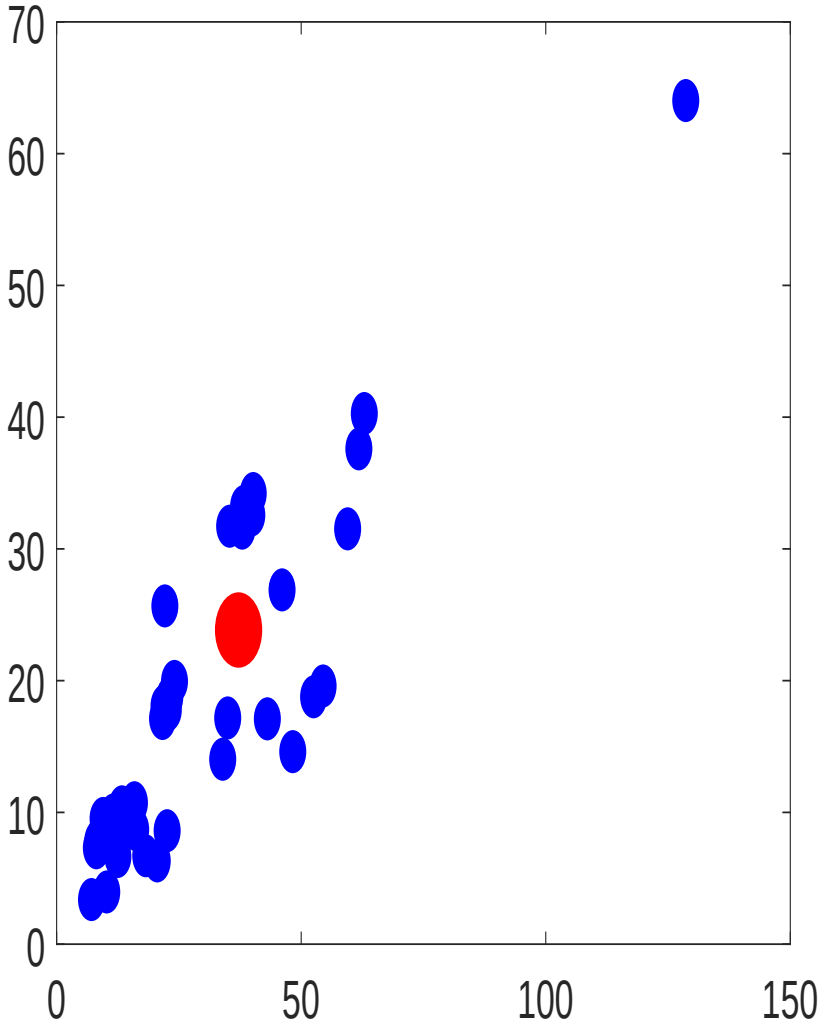
Why?

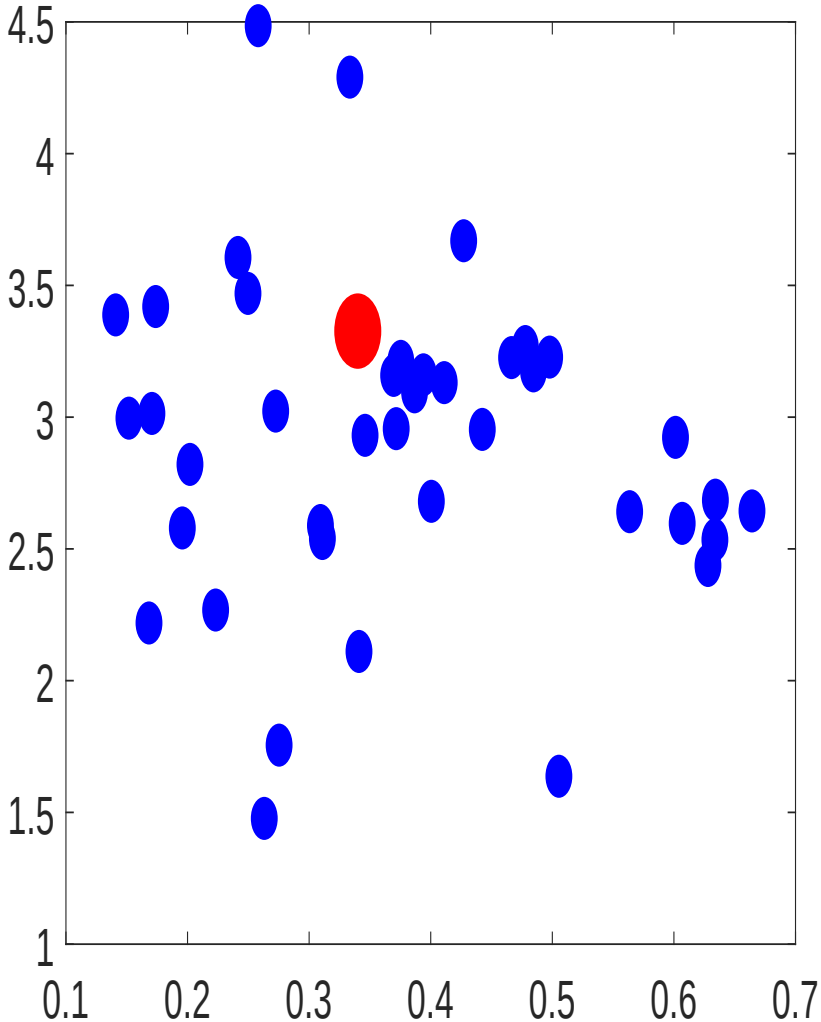
The list of the 40 investment rate measures

(1) CAPX/AT
(2) CAPX/PPENT
(3) dAT/AT
(4) (dPPEGT+dINVT)/AT
(5) Inv/AT
(6) CAPX/PPEGT
(7) dPPEGT/AT
(8) (dPPENT+DP)/PPENT
(9) (CAPX−SPPE)/PPEGT
(10) (CAPX−SPPE)/AT
(11) dPPENT/AT
(12) (CAPX+AQC)/AT
(13) CAPXV/AT
(14) (CAPX−SPPE)/PPENT
(15) (CAPX+AQC−SPPE)/AT
(16) (CAPXV−SPPE)/AT
(17) dPPEGT/PPEGT
(18) dPPENT/PPENT
(19) (dPPENT+DP)/AT
(20) (CAPXV−SPPE)/PPEGT
(21) dBe/Be
(22) (CAPX−SPPE)/avePPENT
(23) dNoa/AT
(24) dLno/aveAT
(25) dNca/AT
(26) dBe/AT
(27) (CAPXV+AQC)/PPENT
(28) CAPXV/PPENT
(29) CAPXV/PPEGT
(30) (CAPX+IVCH−SIV)/(PPENT+IVAEQ+IVAO)
(31) (dPPENT+WDP+DPC)/PPEGT
(32) dNAT/NAT
(33) CAPX/(AT−INVT)
(34) (CAPX+AQC)/PPEGT
(35) CAPX/(PPENT−CAPX+DP)
(36) (CAPXV−SPPE)/(AT−ACT)
(37) (CAPXV−SPPE)/PPENT
(38) (CAPX−DP)/AT
(39) CAPX/(AT−CHE)
(40) dNCAT/NCAT

Why?

Mean versus standard deviation and skewness versus the serial correlation across the 40 investment rates in Compustat, 1963–2020





How?

Building firm-specific current-cost capital stocks in the entire Compustat universe

Investment as dPPENT+DP per Hayashi and Inoue (1991)

BEA's industry-specific capital/investment price deflators assigned to firms via a meticulous Compustat firm-NAICS mapping

BEA's industry economic depreciation rates assigned to firms

Initial values of current-cost capital based on PPEGT and asset age via perpetual inventory method (PIM)

How?

Another meta-study on prior 33 PIM studies at the firm level; only 10 from 2000 onward in the top-five finance journals

Most use small samples with only manufacturing firms

Most measure investment as capital expenditure

Most use a single, aggregate capital price deflator for fixed nonresidential investment

Most estimate firm-specific but constant economic depreciation rates via the Salinger-Summers double-declining method

How?

Selected PIM studies at the firm level

	Sample	Investment flows	Price deflators	Depreciation rates
Lindenberg and Ross (1981)	246 firms, 1960–1977	"gross investment (book) in plant and equipment"	Nonresidential fixed investment price deflator	Accounting depreciation, also tech. progress
Salinger and Summers (1983)	30 Dow Jones companies, 1959–1978	proportional to aggregate investment and aligned with gross PPE in 1959	CPI	double declining
Fazzari, Hubbard, and Petersen (1988)	Manuf. firms, 1970–198, Value Line	"capital spending"	Implicit price deflator for fixed nonresid. investment	single declining
Hall (1990)	Compustat, 1979–1987		GNP deflator for fixed nonresidential investment	Accounting depreciation rate
Hayashi and Inoue (1991)	687 Japanese manuf. firms, 1977–1986	change in net PPE plus accounting depreciation	nonresid. buildings and structures as the construction material part of Wholesale Price Index (WPI) from BoJ; machinery and instruments and tools as weighted averages of subcomponents in WPI; transportation equipment as the matching component of WPI; the urban land prices index	4.7% for nonresid. buildings; 5.64% for structures; 9.489% for machinery; 14.7% for transportation equipments; 8.838% for instruments and tools; 0% for land

How?

Selected PIM studies at the firm level

	Sample	Investment flows	Price deflators	Depreciation rates
Whited (1992)	325 manuf. firms, 1972–1986	capital expenditure on PPE	GNP price deflator for nonresid. investment	double declining
Barnett and Sakellaris (1998)	manuf. firms from Hall (1990)	capital expenditure on PPE	GNP deflator for fixed nonresid. investment	accounting depreciation rate
Abel and Eberly (2001)	Compustat, 604 firms on average per year, 1974–1993	capital expenditure on PPE minus sales of PPE	implicit price deflator for nonresid. investment	2-digit SIC-industry, double declining
Chirinko and Schaller (2009)	Compustat, 1980–2001	CAPX; for acquisition, change in PPEGT plus PPE retirements; for disinvestment, change in PPENT plus economic depreciation	sector-specific investment price deflators based on chained dollars from BEA	sector-specific current-cost depreciation rates based on chained dollars from BEA

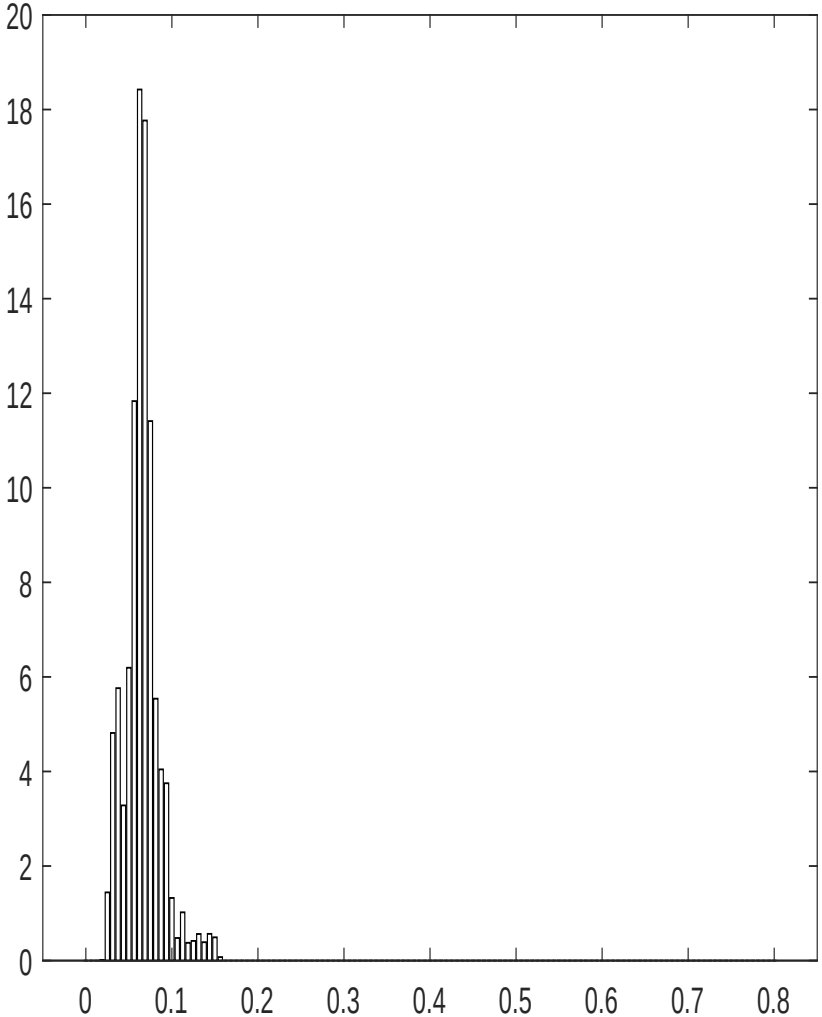
What?

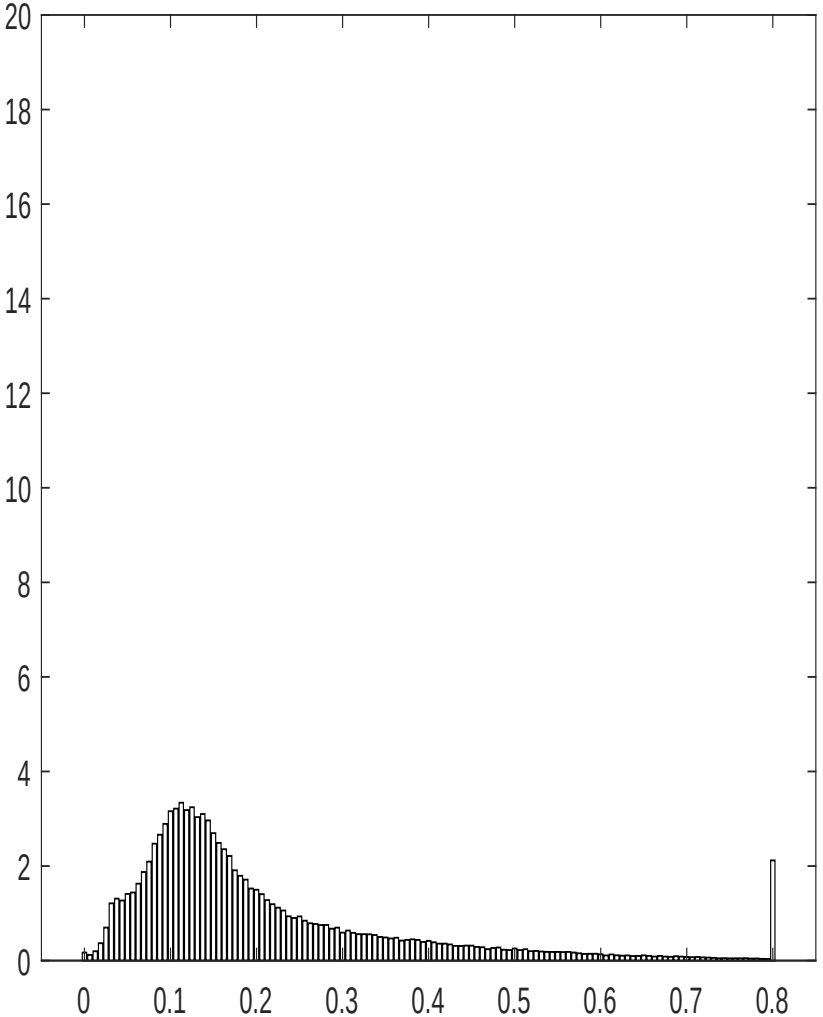
Basic moments of $I^{\$}_{it}/K^{\$}_{it}$, the 1963–2020 sample, 169,828 firm-years

	$I^{\$}_{it}/K^{\$}_{it}$	I^{H}_{it}/K^{H}_{it}	$K^{\$}_{it}/K^{H}_{it}$	δ_{it}	δ^{H}_{it}
Mean	0.238	0.403	2.11	6.90	20.94
Median	0.130	0.228	1.61	6.86	16.10
Standard deviation	0.372	0.629	1.79	1.96	16.65
Autocorrelation	0.34	0.25	0.9	0.98	0.79
Skewness	3.33	3.47	3.58	0.65	2.01
Excess kurtosis	14.28	15.84	16.82	1.37	6.08

What?

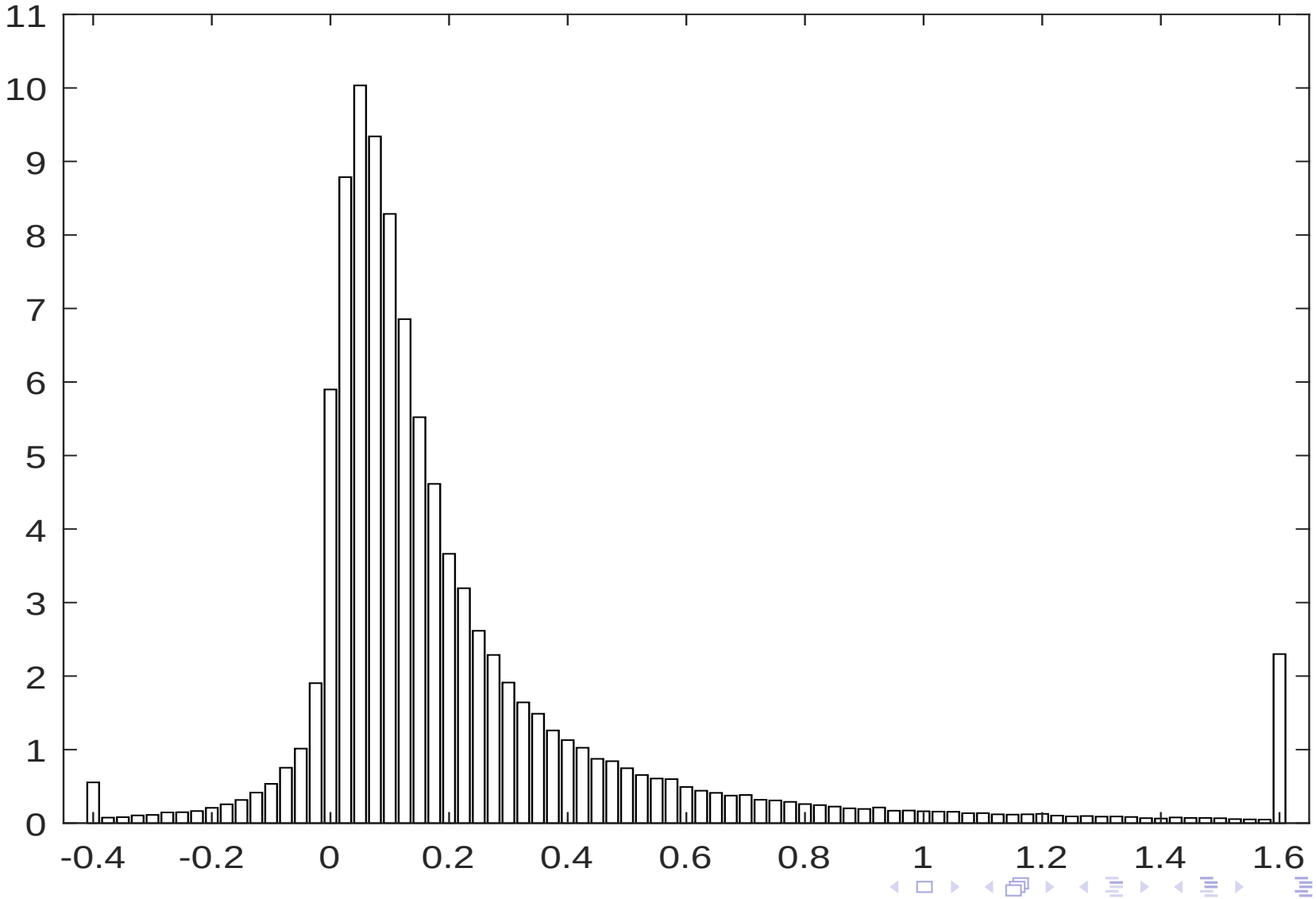
Economic depreciation rates, δ_{it} (169,792 firm-years);
accounting depreciation rates, δ_{it}^{H} (177,412 firm-years)





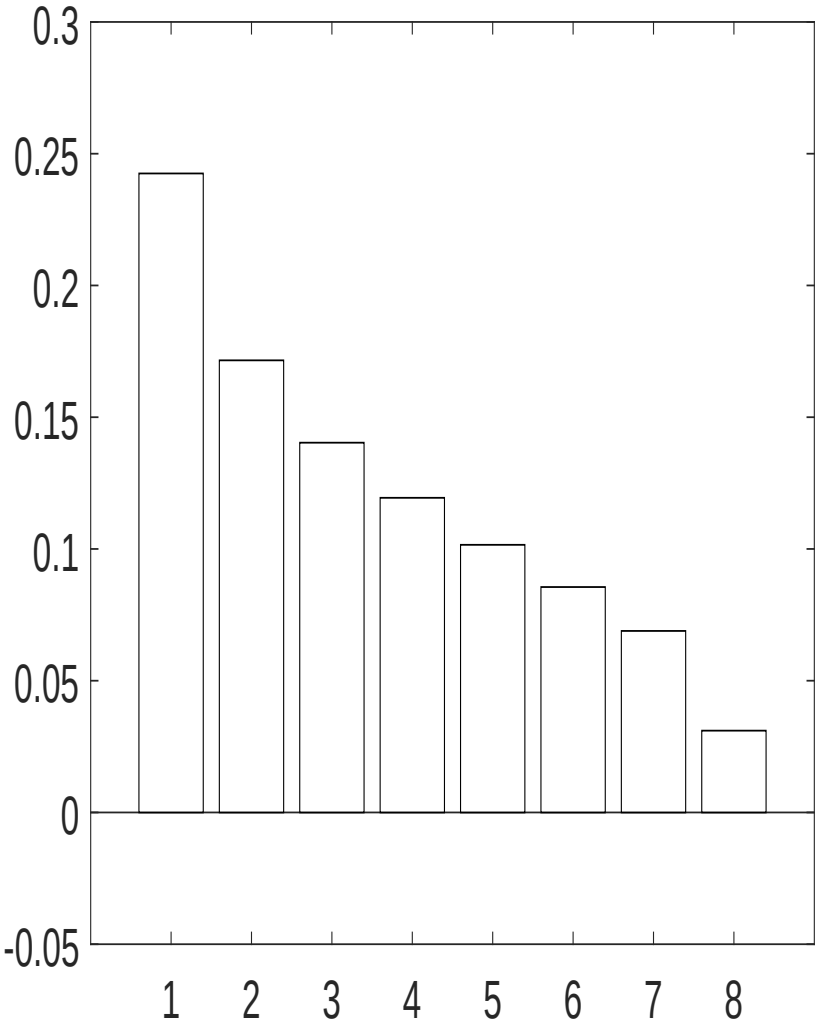
What?

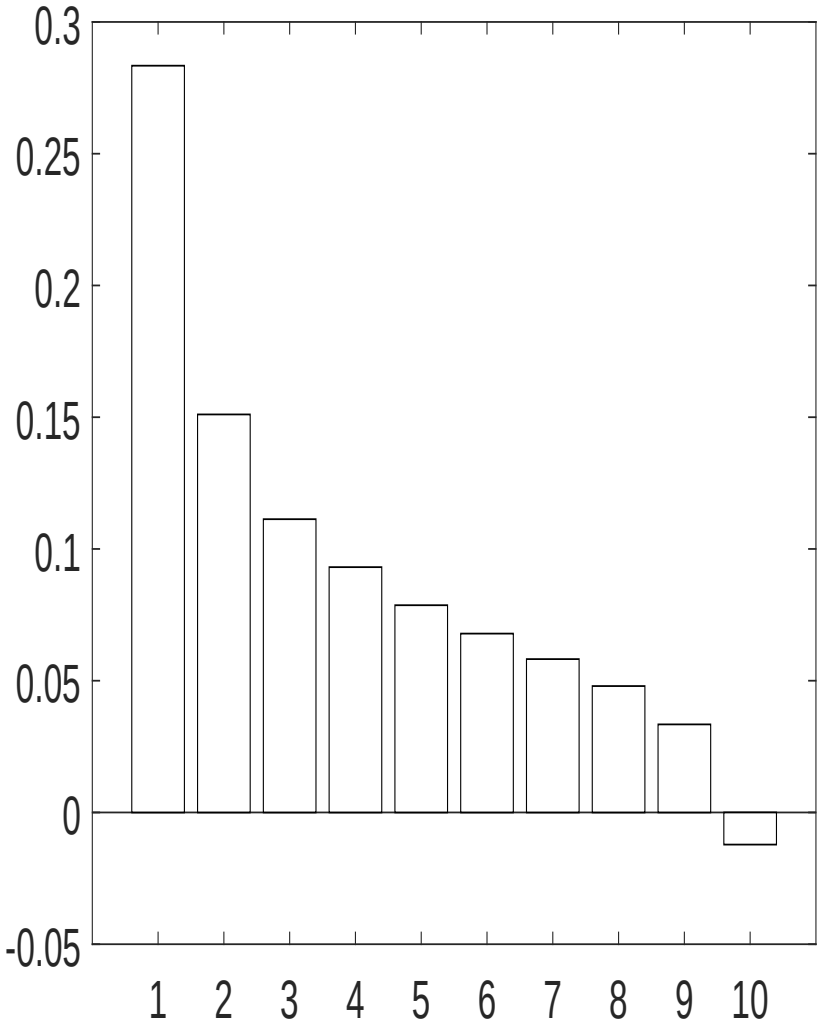
The asymmetric firm-level $I_{it}^{\$}/K_{it}^{\$}$ distribution: The fractions of negative, inactive, and positive investment rates: 5.51%, 2.85%, and 91.64%, respectively; a rate of 1.26% for negative spikes (below -20%) versus 32.7% for positive spikes (above 20%)



What?

Lumpy firm-level $I_{it}^{\$}$: For a typical firm, 39% of total $|I_{it}^{\$}|$ done within 20% of the years in the Doms-Dunne (1998) tests; balanced panels by decade: 1963–1970 and 2011–2020





Outline

Outline

Obtain the domestic supply of each capital good from production data of capital goods producing industries

Subtract capital purchases by government and consumers to compute gross investment flows by asset class

Distribute investment totals by asset class across industries with strong assumptions on the employment-capital relation

Form capital stocks by asset class by applying PIM on investment flows, depreciation profiles, and investment price deflators (PPIs)

Geometric depreciation, closer to actual profiles of used capital price declines in the data (Hulten and Wykoff 1981a, b)

The economic depreciation rate of asset a, $\delta_a = B_a/L_a$, in which B_a is its declining-balance rate, and T_a the average service life

B_a on average 1.65 for equipment and 0.91 for nonresidential structures; both lower than 2 (the double-declining-balance rate)

Meta-Analysis

Plant-level studies; balanced panels from Longitudinal Research Database (LRD) in the 1972–1988 sample; left-censored at 1972; mostly sampling rotation every 5 year

Cooper and Haltiwanger (2006):

- A "striking asymmetry between positive and negative investment": A fraction of 10.4% for negative, 8.1% for inactive, and 81.5% for positive investment rates

Doms and Dunne (1998):

- Lumpiness: For each plant, calculate the fraction of investment each year out of total investment; top 3 years account for 50.1%

Macro accounting: Top-down supply-based; geometric depreciation

Micro accounting: demand-based; straight-line depreciation

- Net PPE should be net capital; yet many scale investment with gross PPE or book assets
- Accounting $\gg$ geometric depreciation rates
- Scaling by gross PPE or book assets brings basic investment rate moments closer to the BEA's

Build current-cost capital stocks with economic depreciation rates

Outline

The quantity of capital stock accumulates as:

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

δ_{it}: The economic depreciation rate

Rewriting in terms of current costs yields:

$$K^{\$}_{it+1} = \left((1 - \delta_{it}) \frac{K^{\$}_{it}}{P^{K}_{it}} + \frac{I^{\$}_{it}}{P^{I}_{it}} \right) P^{K}_{it+1}$$

P^{K}_{it}: Capital price deflator; P^{I}_{it}: Investment price deflator

PIM requires: (i) current-cost investment flows, $I^{\$}_{it}$; (ii) P^{K}_{it} and P^{I}_{it}; (iii) δ_{it}; and (iv) the initial current-cost capital stock, $K^{\$}_{i0}$

Economic Accounting

Investment flows = change in PPENT + accounting depreciation; accounting identities by expanding on Hayashi and Inoue (1991)

Net PPE equals gross PPE minus accumulated depreciation:

$$\text{PPENT}_t = \text{PPEGT}_t - \text{DPACT}_t$$

ACQ_t: Gross book value of acquired fixed assets;
SR_t: Gross value of disposed fixed assets:

$$\text{PPEGT}_{t+1} = \text{PPEGT}_t + \text{ACQ}_t - \text{SR}_t$$

ACDACQ_t: Accumulated depreciation of acquired fixed assets;
ACDSR_t: Accumulated depreciation for disposed fixed assets:

$$\text{DPACT}_{t+1} = \text{DPACT}_t + \text{DP}_t + \text{ACDACQ}_t - \text{ACDSR}_t$$

Economic Accounting

Assume current-cost equals historical-cost investment flows

$$
\begin{aligned}
I_{it}^{H} &= \text{PPENT}_{t+1} - \text{PPENT}_{t} + \text{DP}_{t} \\
&= \text{PPEGT}_{t+1} - \text{PPEGT}_{t} - (\text{DPACT}_{t+1} - \text{DPACT}_{t}) + \text{DP}_{t} \\
&= \text{PPEGT}_{t+1} - \text{PPEGT}_{t} - \text{ACDACQ}_{t} + \text{ACDSR}_{t} \\
&= (\text{ACQ}_{t} - \text{ACDACQ}_{t}) - (\text{SR}_{t} - \text{ACDSR}_{t}) \\
&= \text{NACQ}_{t} - \text{NSR}_{t}
\end{aligned}
$$

Change in gross PPE underestimates the magnitude of investment by 17.2%; poor coverage of $\text{NACQ}_t - \text{NSR}_t$

For acquired assets, historical costs are close to current costs; for disposed assets, typically, historical costs $\neq$ current costs

Sales of PPE underestimate disinvestment:

- Ignores asset-for-equity and asset-for-debt sales
- Ignores other disposition methods, such as exchanges of nonmonetary assets, involuntary conversion (fire, flood, theft, and condemnation), and retirements
- Ignores spin-offs and changes in consolidation status (when a subsidiary is no longer consolidated)

However, dPPENT+DP likely overstates disinvestment via restructuring charges, impairment losses, and FX translations

Economic Accounting

Capital and investment price deflators; based on our extensive discussion with the BEA staff

Detailed tables for 63 private industries (the fixed assets accounts):

- Current-cost (current-dollar) capital stocks in private non-residential equipment, $K_{jt}^{\mathcal{E}\$}$, and structure, $K_{jt}^{\mathcal{S}\$}$; fixed-cost (constant-dollar) capital stocks in private non-residential equipment, $K_{jt}^{\mathcal{E}}$, and structure, $K_{jt}^{\mathcal{S}}$
- Current-cost investments in private non-residential equipment, $I_{jt}^{\mathcal{E}\$}$, and structure, $I_{jt}^{\mathcal{S}\$}$; fixed-cost investments in private non-residential equipment, $I_{jt}^{\mathcal{E}}$, and structure, $I_{jt}^{\mathcal{S}}$

Industry j's capital and investment price deflators:

$$P_{jt}^{K} = \frac{K_{jt}^{\mathcal{E}\$} + K_{jt}^{\mathcal{S}\$}}{K_{jt}^{\mathcal{E}} + K_{jt}^{\mathcal{S}}}; \qquad P_{jt}^{I} = \frac{I_{jt}^{\mathcal{E}\$} + I_{jt}^{\mathcal{S}\$}}{I_{jt}^{\mathcal{E}} + I_{jt}^{\mathcal{S}}}$$

Sector s's capital and investment price deflators:

$$P_{st}^{K} = \frac{\sum_{j\in s} K_{jt}^{\mathcal{E}\$} + \sum_{j\in s} K_{jt}^{\mathcal{S}\$}}{\sum_{j\in s} K_{jt}^{\mathcal{E}} + \sum_{j\in s} K_{jt}^{\mathcal{S}}}; \qquad P_{st}^{I} = \frac{\sum_{j\in s} I_{jt}^{\mathcal{E}\$} + \sum_{j\in s} I_{jt}^{\mathcal{S}\$}}{\sum_{j\in s} I_{jt}^{\mathcal{E}} + \sum_{j\in s} I_{jt}^{\mathcal{S}}}$$

Fixed-cost depreciation in private non-residential equipment, $D^{\mathcal{E}}_{jt}$, and structure, $D^{\mathcal{S}}_{jt}$; fixed-cost capital in private non-residential equipment, $K^{\mathcal{E}}_{jt}$, and structure, $K^{\mathcal{S}}_{jt}$; and fixed-cost investment in private non-residential equipment, $I^{\mathcal{E}}_{jt}$, and structure, $I^{\mathcal{S}}_{jt}$

Industry j's economic depreciation rate in year t:

$$\delta_{jt} = \frac{D^{\mathcal{E}}_{jt} + D^{\mathcal{S}}_{jt}}{(K^{\mathcal{E}}_{jt-1} + K^{\mathcal{S}}_{jt-1}) + 0.5 \times (I^{\mathcal{E}}_{jt} + I^{\mathcal{S}}_{jt})}$$

Different from current-cost depreciation rate, $\delta^{\$}_{jt}$

Economic Accounting

The initial values of current-cost capital stocks via the PIM based on asset age; inspired by Salinger and Summers (1983) but differ in many details

Left-censoring still in Compustat (no sampling rotation)

In year 0 (first year with available net and gross PPE), estimate oldest asset age, A_i, as DPACT/DP times 2

Estimate $K_{i0}^{\$}$ from iterating from year $-A_i$ to year 0, with the initial capital of 0 and investment $\text{PPEGT}_{i0}/(A_i + 1)$ each year

Outline

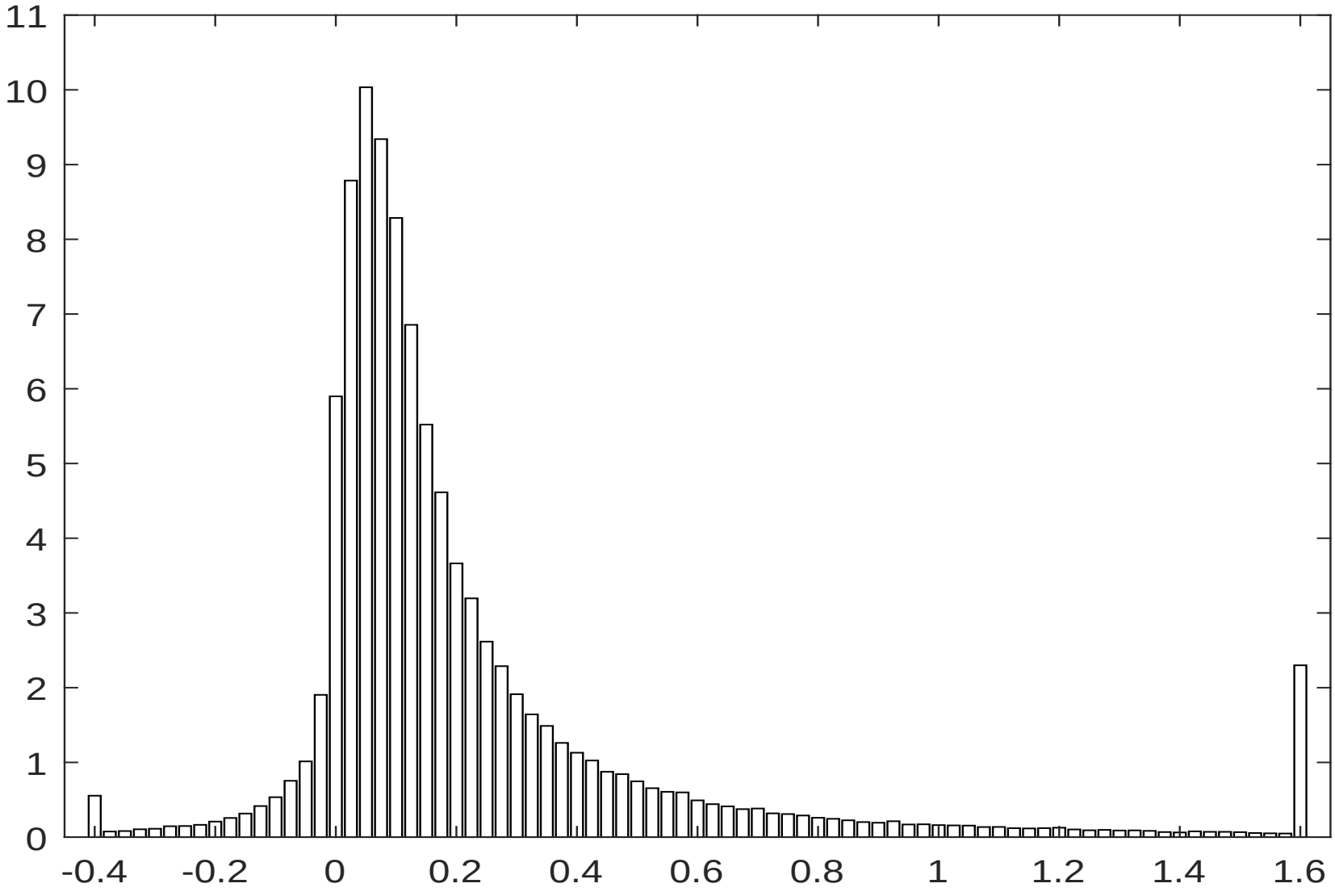
Properties

Basic investment rate moments in Compustat, 1963–2020; $I^{\$}_{it}/K^{\$}_{it}$: Current-cost investment rates; $I_{it}/K_{it} \equiv (I^{\$}_{it}/K^{\$}_{it})(P^{K}_{it}/P^{I}_{it})$: Real investment rates

	Mean	Std	Skew	Kurt	5th	25th	50th	75th	95th	ρ_1
$I^{\$}_{it}/K^{\$}_{it}$	23.84	37.20	3.33	14.28	−1.97	6.19	13.03	26.70	87.07	0.34
I_{it}/K_{it}	20.43	31.48	3.30	14.15	−1.72	5.42	11.37	23.07	73.97	0.33
$(\text{CAPX}-\text{SPPE})/K^{\$}_{it}$	19.36	24.71	3.08	11.99	1.44	6.46	11.89	22.00	63.80	0.51
	f_{-}	f_0	$f^{-}_{0.2}$	$f^{-}_{0.3}$	$f^{-}_{0.4}$	$f^{-}_{0.5}$	$f^{+}_{0.2}$	$f^{+}_{0.3}$	$f^{+}_{0.4}$	$f^{+}_{0.5}$
$I^{\$}_{it}/K^{\$}_{it}$	5.51	2.85	1.26	0.73	0.44	0.28	32.66	20.70	14.49	10.80
I_{it}/K_{it}	5.42	3.26	1.08	0.58	0.33	0.21	28.19	17.34	11.88	8.76
$(\text{CAPX}-\text{SPPE})/K^{\$}_{it}$	1.81	2.72	0.36	0.22	0.15	0.10	27.52	15.85	10.26	7.24

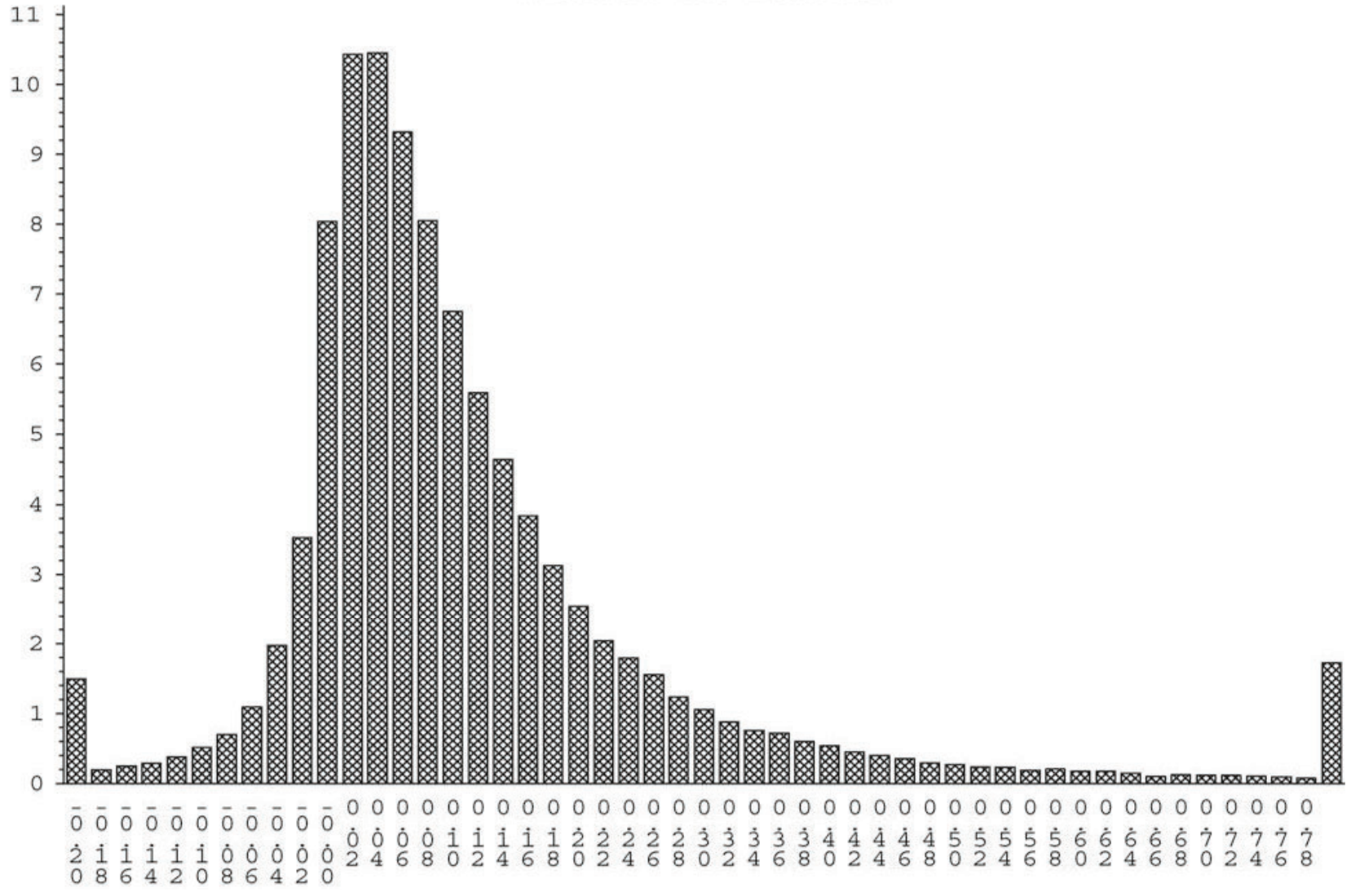
Properties

Asymmetric firm-level investment rates; the fractions of negative, inactive, and positive rates: 5.51%, 2.85%, and 91.64%, respectively



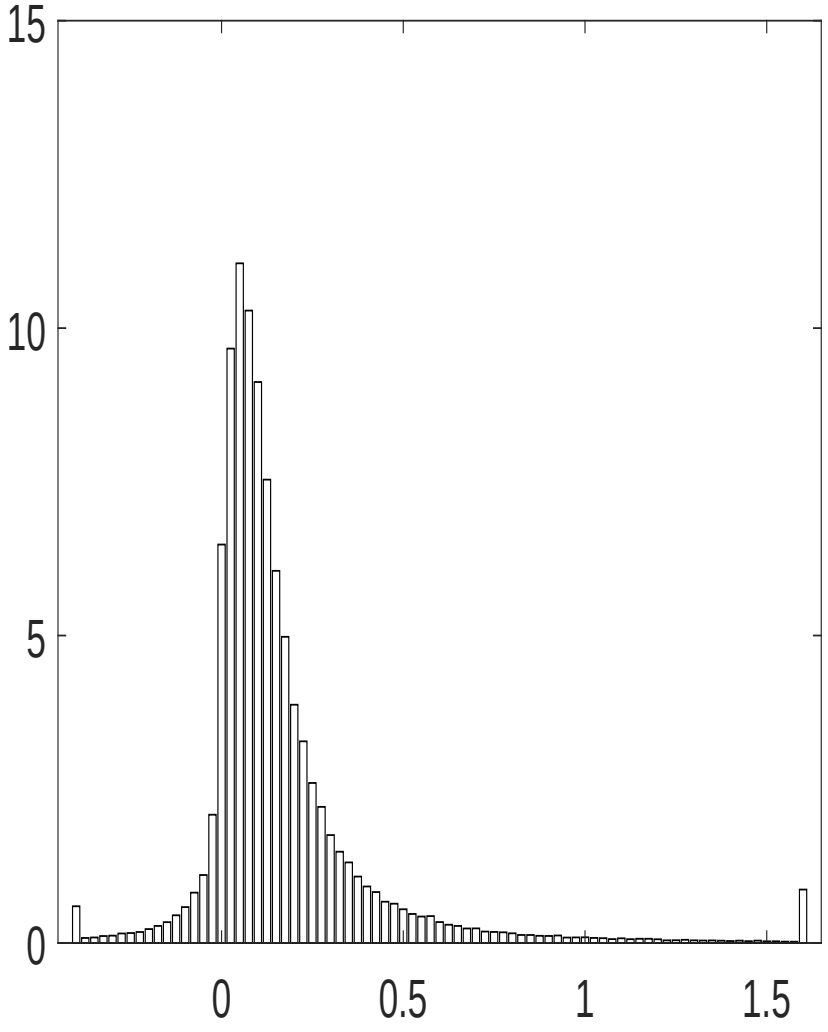
Properties

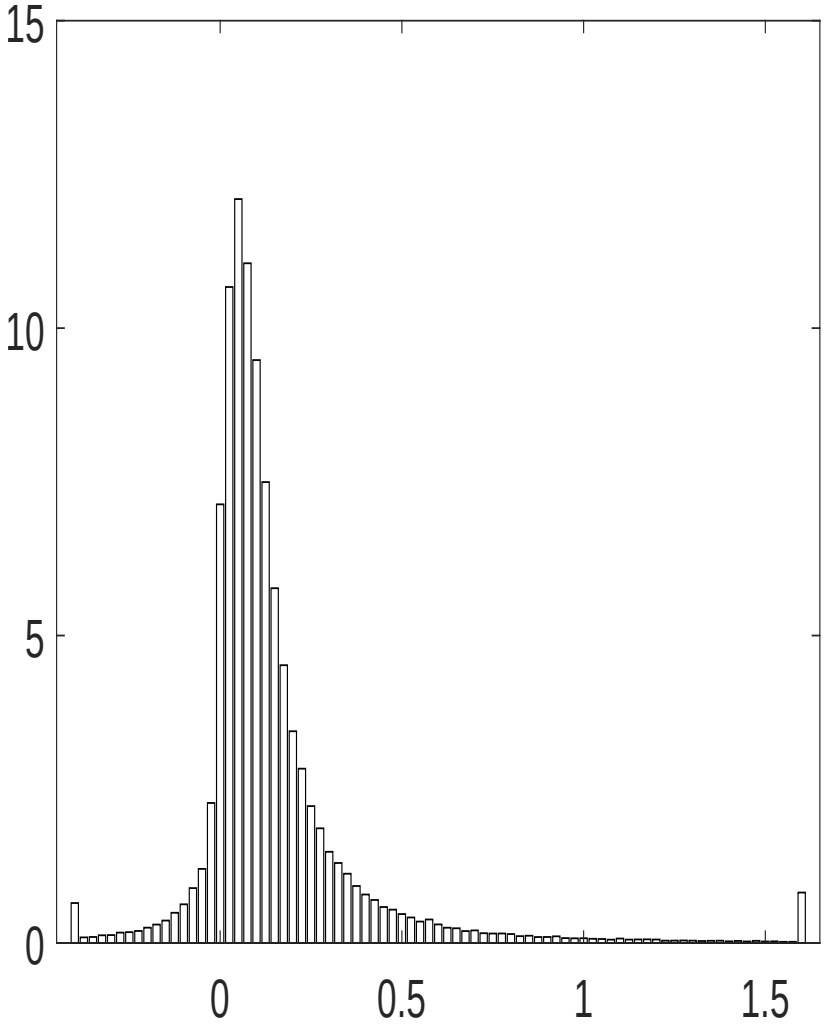
Asymmetric plant-level investment rates (Cooper and Haltiwanger 2006); the fractions of negative, inactive, and positive rates: 10.4%, 8.1%, and 81.5%, respectively



Properties

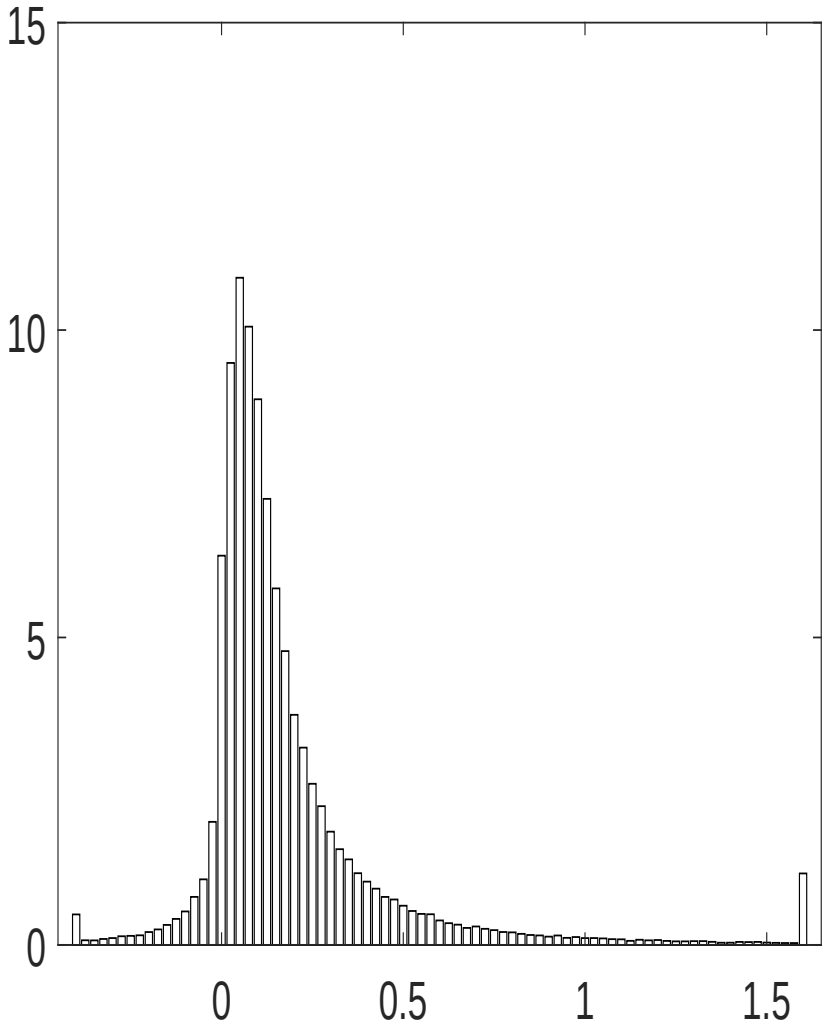
Asymmetric investment rates: $(I-\text{CAPX})/K^{\$} \leq 15\%$ versus $(I-\text{CAPX})/K^{\$} \leq 5\%$

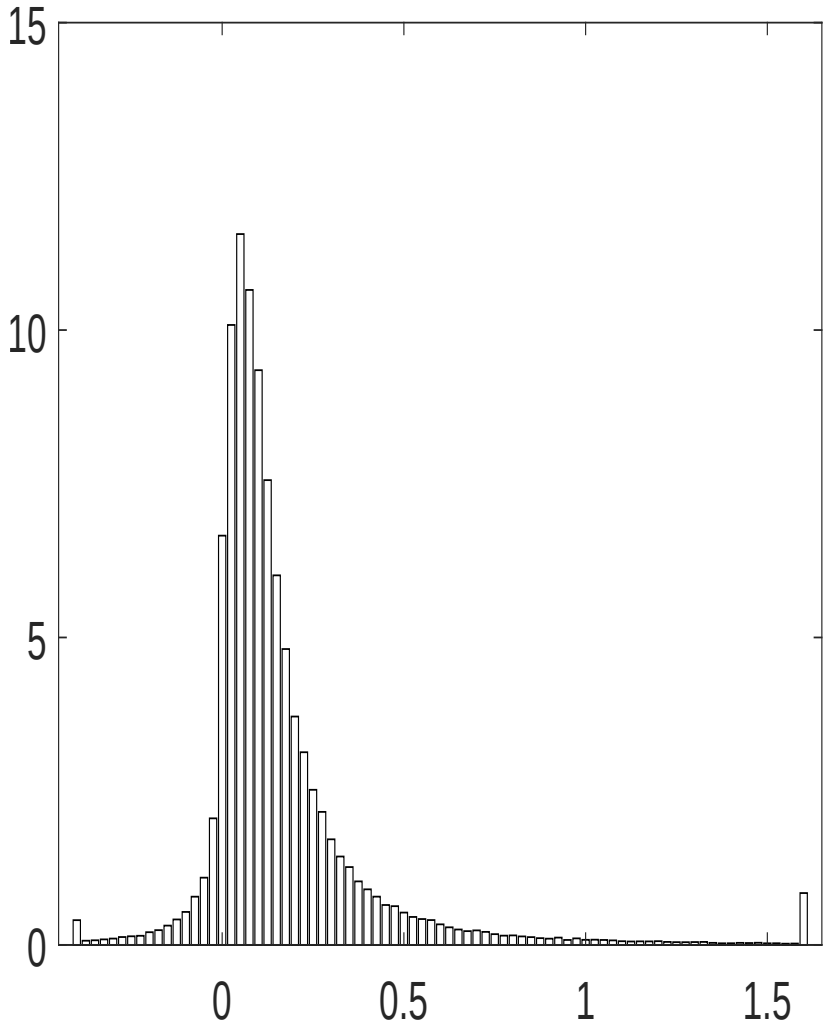




Properties

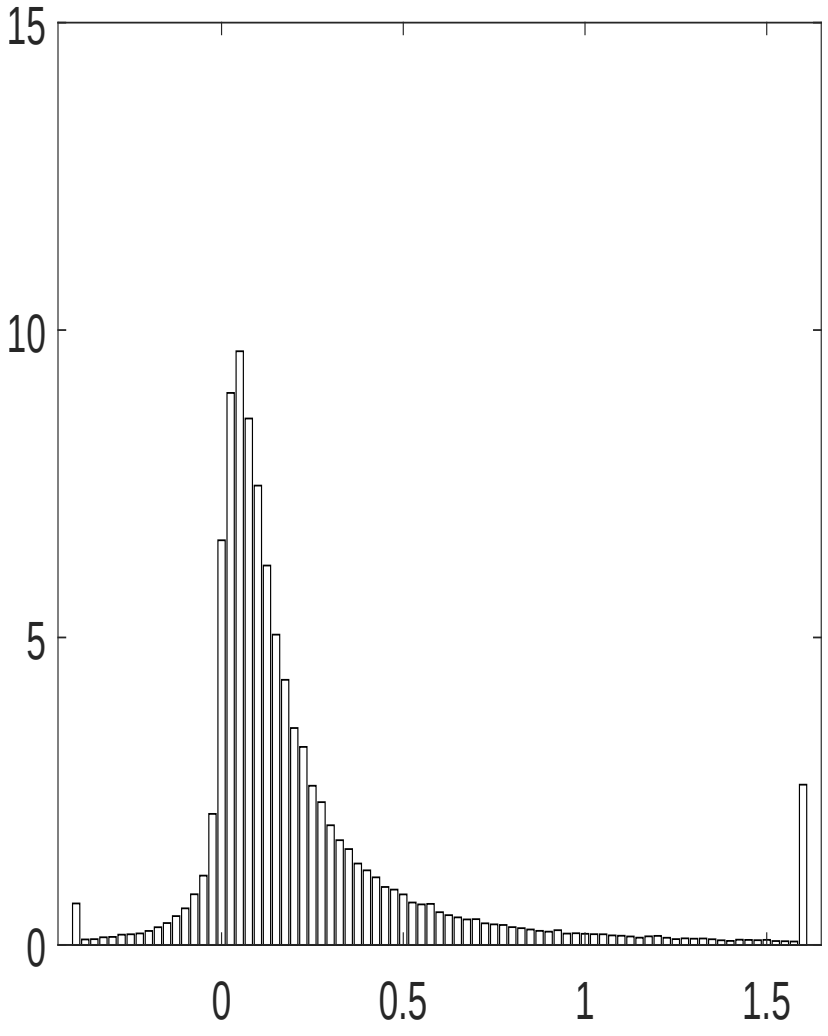
Asymmetric investment rates: No first 3 years versus no first 5 years of observations

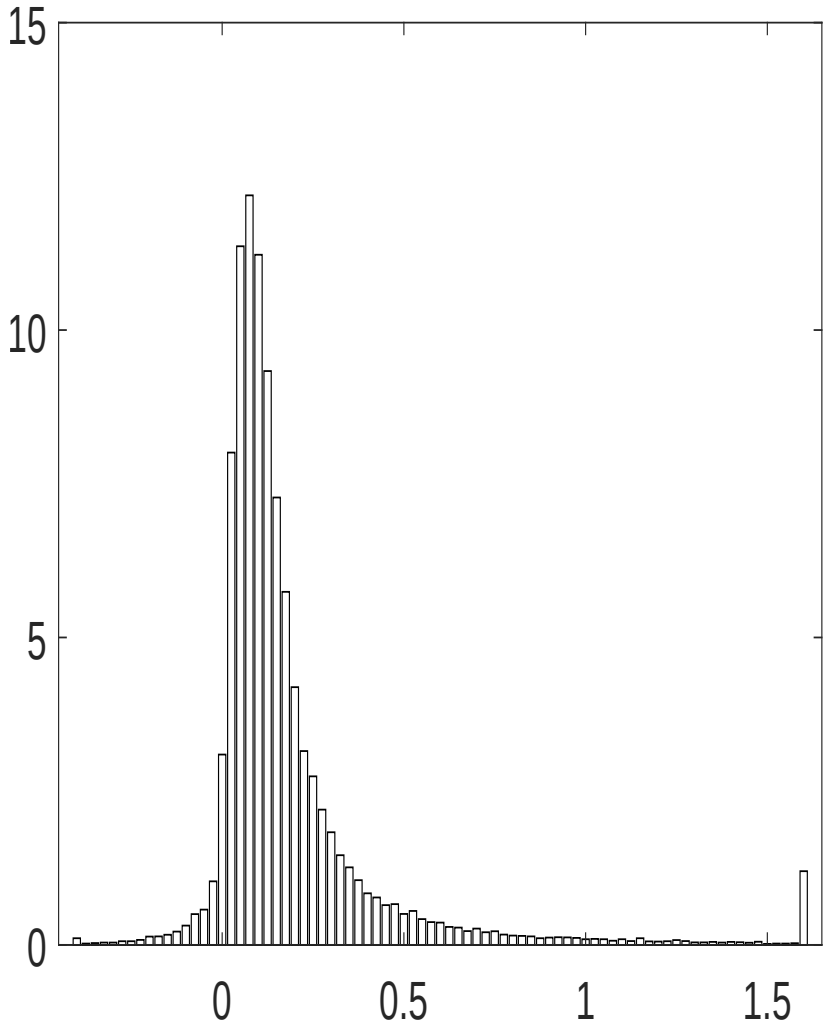




Properties

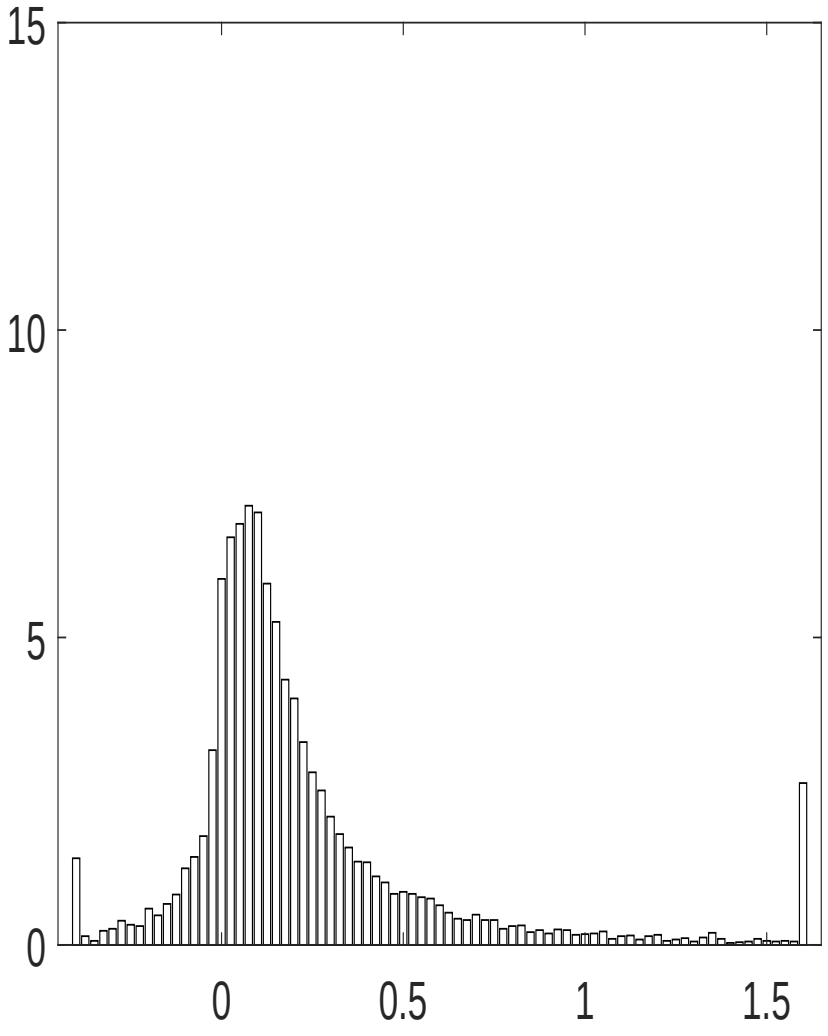
Asymmetric investment rates: Small market equity versus big market equity

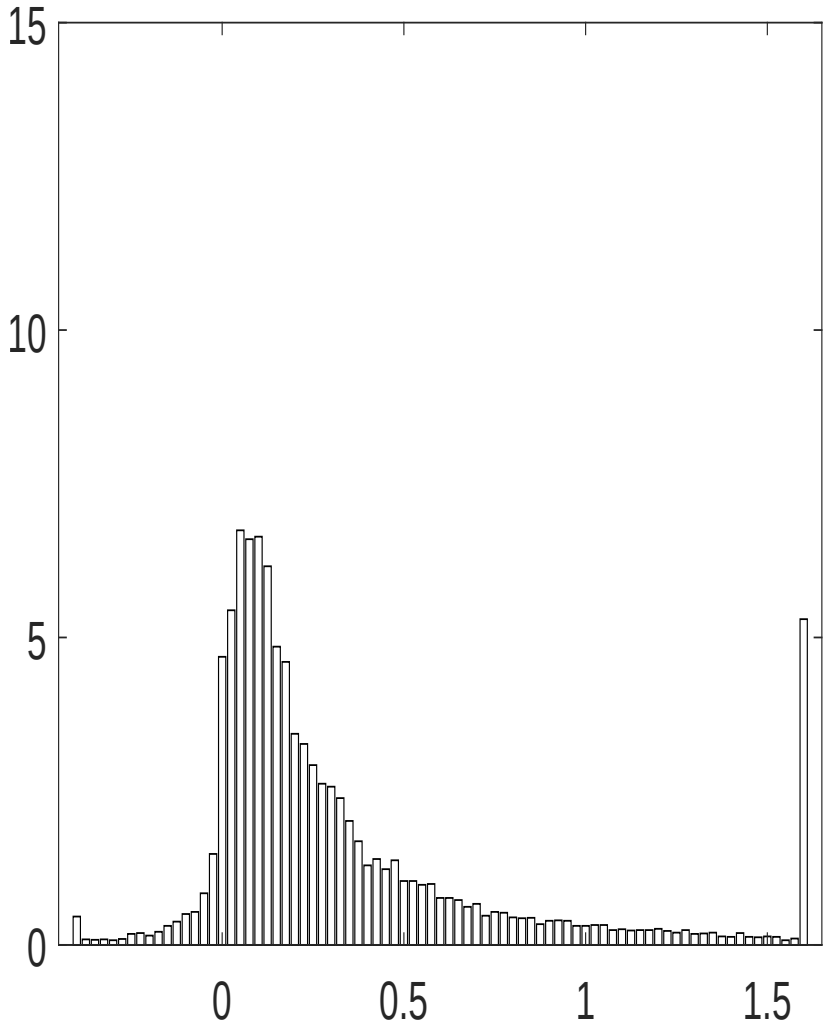




Properties

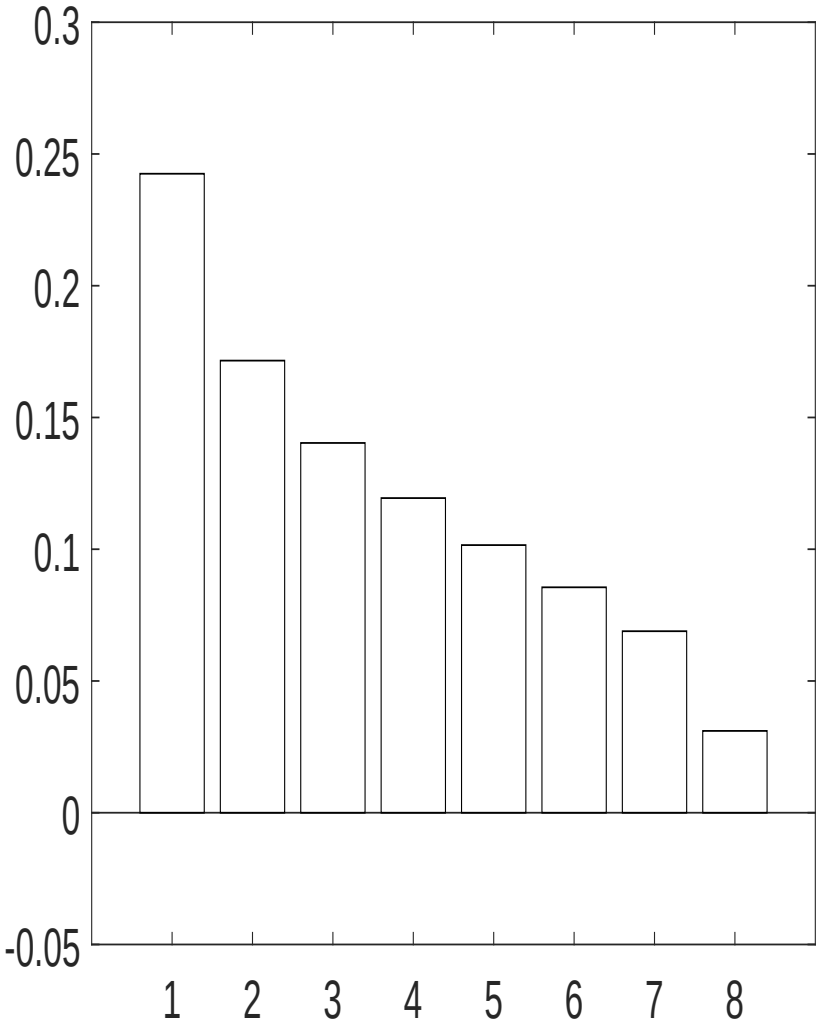
Asymmetric investment rates: Mining versus information sector (2 out of 19)

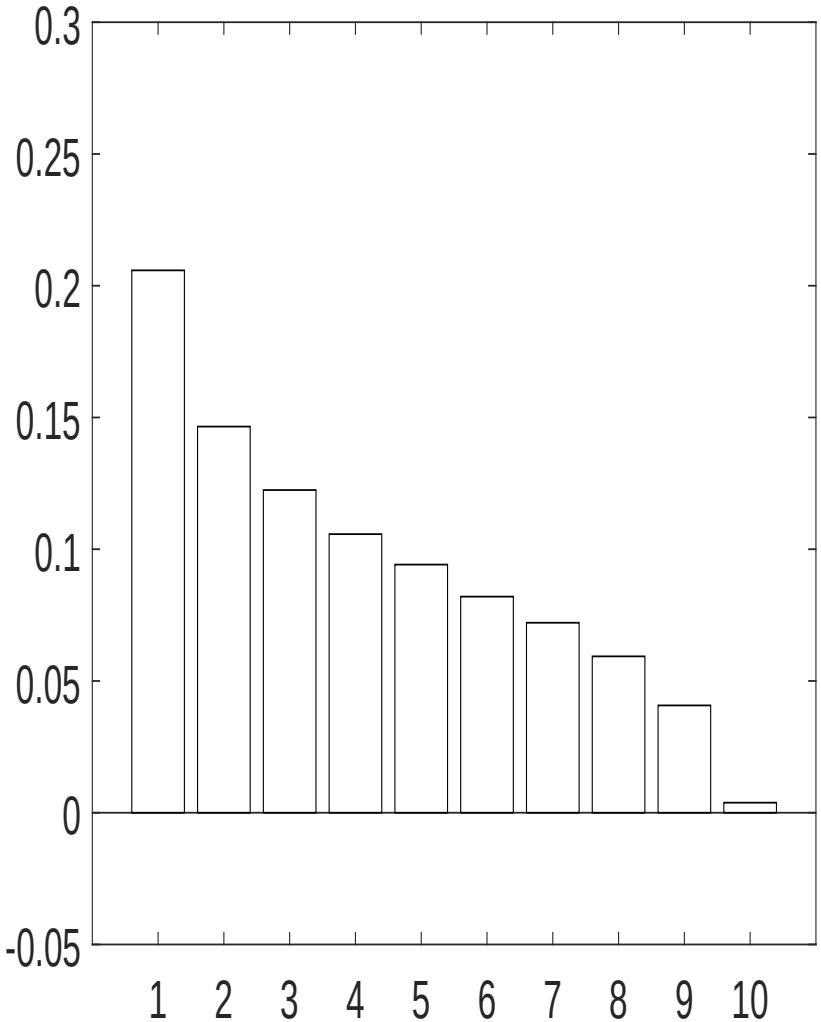




Properties

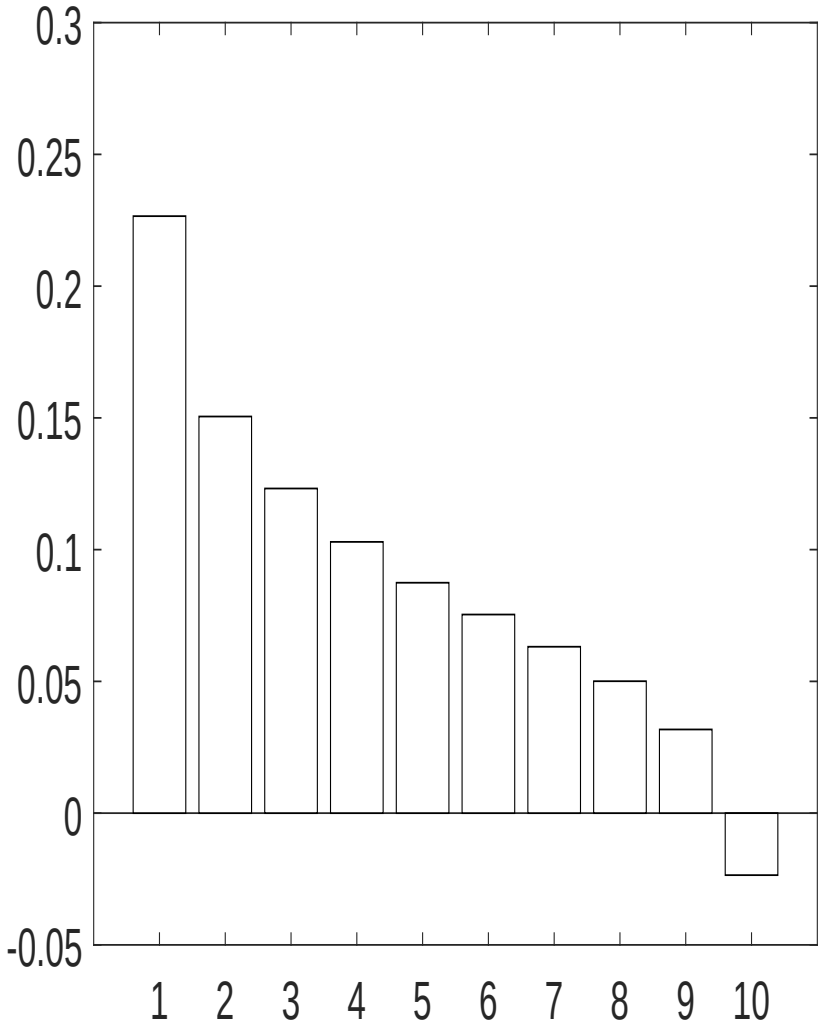
Lumpy investment: For a typical firm, 39% of total $|I_{it}^{\$}|$ done within 20% of the years in the Doms-Dunne (1998) tests; balanced panels by decade; 1963–1970 (768, 41.41%) and 1971–1980 (1,218, 35.24%)

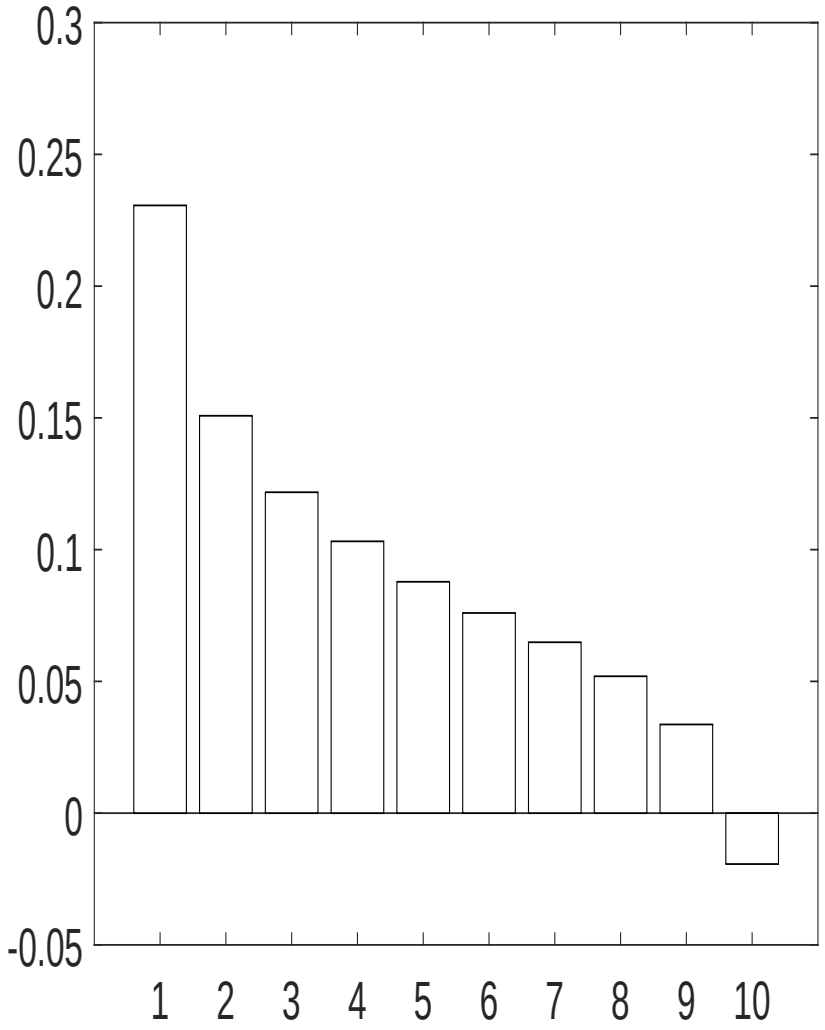




Properties

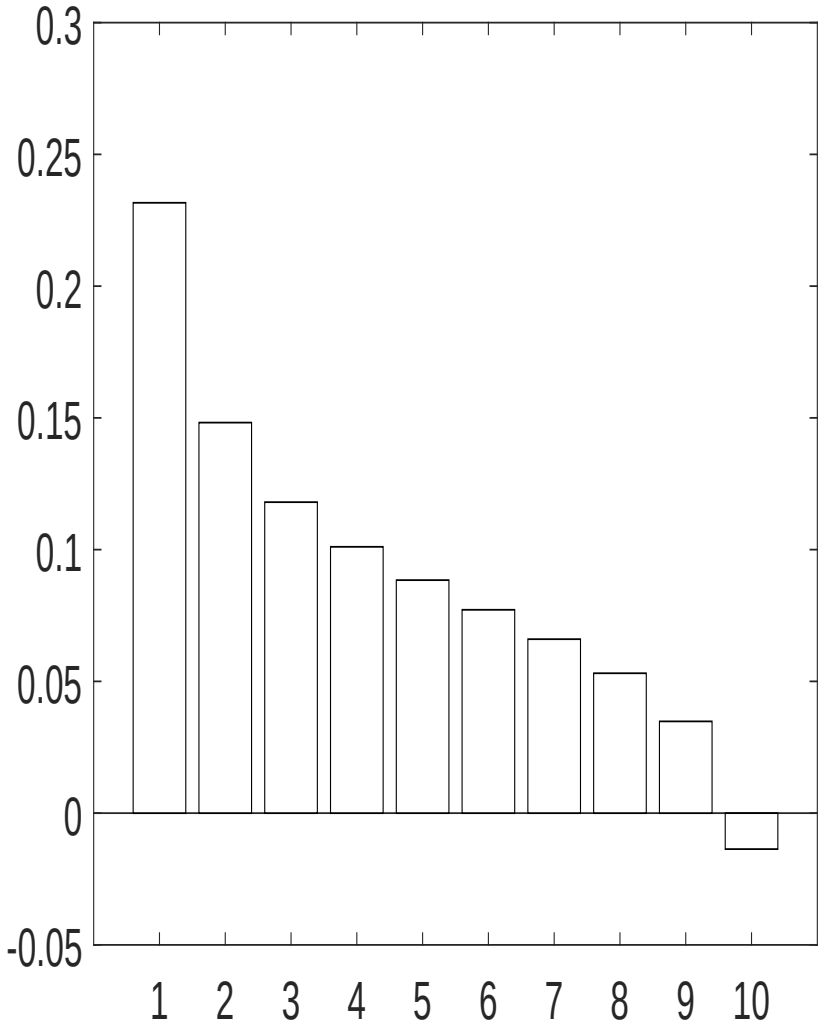
Lumpy investment: 1981–1990 (1,361, 37.71%) and 1991–2000 (1,490, 38.14%)

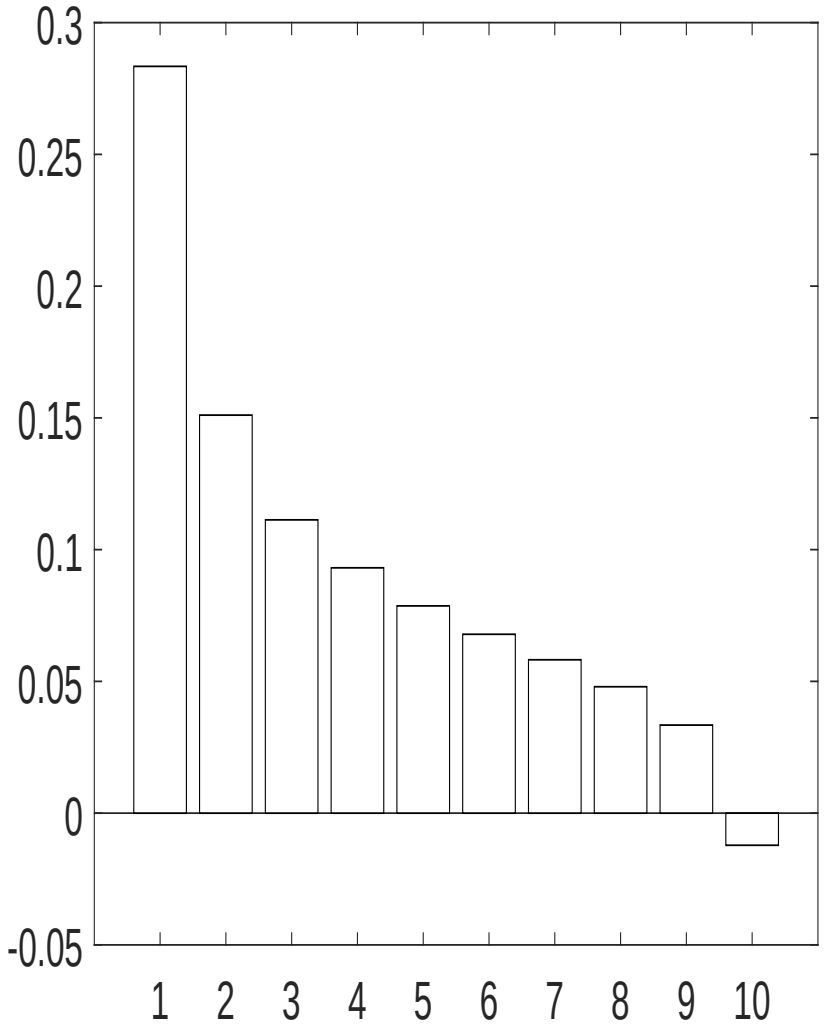




Properties

Lumpy investment: 2001–2010 (1,637, 37.98%) and 2011–2020 (1,281, 43.45%)





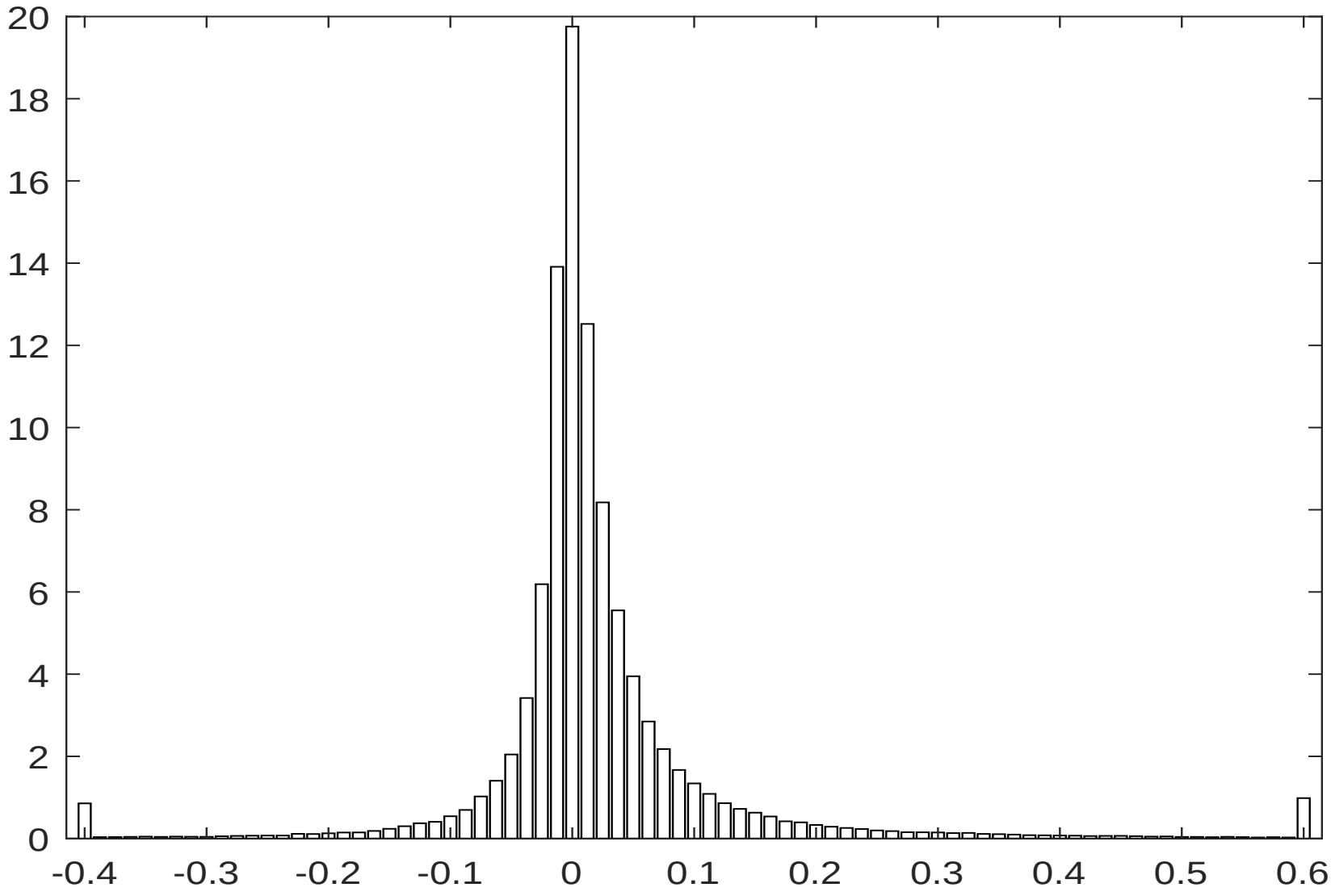
Properties

Differences between current- and historical-cost investment rates, 1963–2020

	Mean	Std	Skew	Kurt	5th	25th	50th	75th	95th	ρ_1
$I^{\$}_{it}/K^{\$}_{it}$	23.84	37.20	3.33	14.28	−1.97	6.19	13.03	26.70	87.07	0.34
I^{H}_{it}/K^{H}_{it}	40.27	62.90	3.47	15.84	−3.95	11.05	22.78	45.33	141.65	0.25
$K^{\$}_{it}/K^{H}_{it}$	2.11	1.79	3.58	16.82	1.01	1.29	1.61	2.16	4.85	0.90
δ_{it}	6.90	1.96	0.65	1.37	3.69	5.91	6.86	7.60	10.69	0.98
δ^{H}_{it}	20.94	16.65	2.01	6.08	4.75	10.81	16.10	26.23	50.69	0.79
$K^{\$}_{it}$/PPEGT	0.98	0.42	3.23	14.86	0.64	0.78	0.88	1.03	1.61	0.91
$K^{\$}_{it}$/AT	0.53	0.39	1.22	1.48	0.09	0.24	0.43	0.73	1.30	0.97
I^{H}_{it}/PPEGT	21.47	34.16	3.48	15.62	−2.11	5.82	11.82	23.66	77.37	0.33
$I^{\$}_{it}/K^{\$}_{it} - I^{H}_{it}$/PPEGT	2.66	9.64	1.04	10.89	−6.79	−0.39	1.35	4.22	16.91	0.48
	f_{-}	f_0	$f^{-}_{0.2}$	$f^{-}_{0.3}$	$f^{-}_{0.4}$	$f^{-}_{0.5}$	$f^{+}_{0.2}$	$f^{+}_{0.3}$	$f^{+}_{0.4}$	$f^{+}_{0.5}$
$I^{\$}_{it}/K^{\$}_{it}$	5.51	2.85	1.26	0.73	0.44	0.28	32.66	20.70	14.49	10.80
I^{H}_{it}/K^{H}_{it}	6.01	1.48	2.18	1.45	0.99	0.66	53.94	37.64	27.53	21.05
I^{H}_{it}/PPEGT	5.59	2.87	1.16	0.64	0.35	0.21	28.92	17.99	12.46	9.20

Properties

$I^{\$}_{it}/K^{\$}_{it} - I^{H}_{it}/\text{PPEGT}$ (169,509 firm-years); I^{H}_{it}/PPEGT not in the prior literature



Conclusion

Potential, broad impact on empirical finance, applied theories, and macroeconomics

Building the data infrastructure of firm-specific current-cost capital stocks for the entire Compustat universe

Characterizing accurately firm-level investment rate properties, including its asymmetry and lumpiness