Low Interest Rates, Market Power, and Productivity Growth

Ernest Liu, Atif Mian, and Amir Sufi

Introduction

- Secular decline in the long-run real interest rate over past decades
- What is the supply-side response to low interest rates?
  - investment decisions, market concentration, and productivity growth

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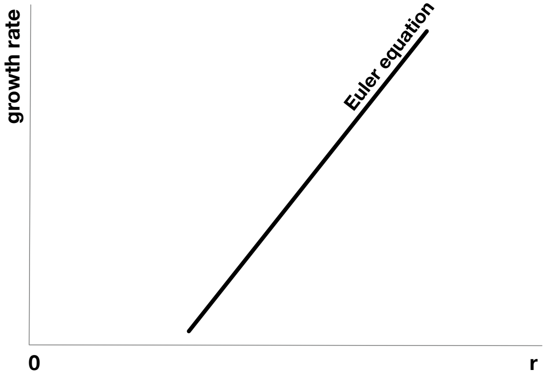

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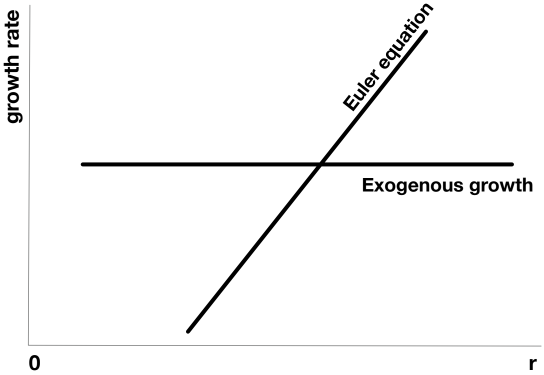

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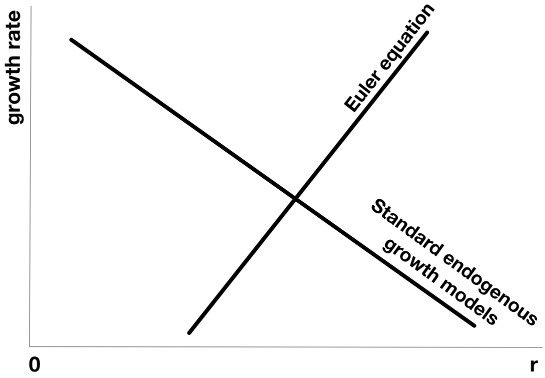

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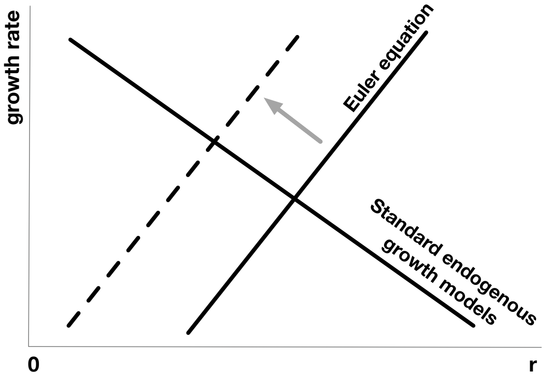

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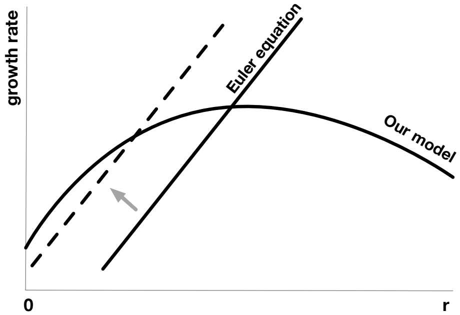
Intuitions: under low r, firms are effectively more "patient"

- For the leader, small prospect of being caught up implies large change in value
- For the follower, low rates motivate investment only if future profits are attainable
  - market leadership becomes *endogenously unattainable* for the follower

Model predictions



- $g\left(r\right)$ has an inverted-U shape

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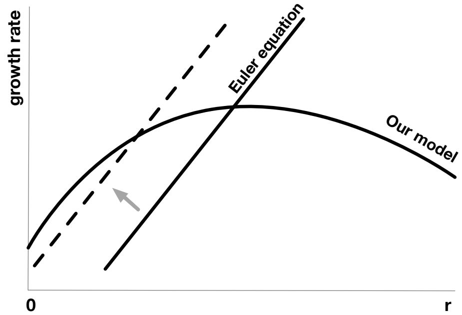

- $g(r)$ has an inverted-U shape

Other steady-state predictions as r declines:

- $\nearrow$ profit share, markups, concentration, leader-follower productivity gap
- $\searrow$ business dynamism, churn, and creative destruction

Short-run predictions:

- declines in r benefit leaders (relative to followers), especially when initial r is low

Model

- Continuous time; a continuum (measure 1) of markets
- Each market has two forward-looking firms competing for profits
  - interest rate r: rate at which future payoffs are discounted

$$v(t) = \int_0^\infty e^{-r\tau} \{\pi(t+\tau) - c(t+\tau)\} \, d\tau$$

- State variable $s \in \{0, 1, \cdots, \infty\}$: a "ladder" of productivity differences
  - $s = 0$: two firms are said to be "neck-to-neck"
  - $s \neq 0$: one firm is the temporary leader while the other is the follower
- Productivity gap s maps into market structure and flow profits: $\{\pi_s, \pi_{-s}\}_{s=0}^\infty$
  - assume π_s, $-\pi_{-s}$, and $(\pi_s + \pi_{-s})$ are bounded, weakly increasing, and eventually concave

Microfoundation for the static block

- Firm with productivity z has marginal cost of production λ^{-z}
  - state variable is defined as the (log-)productivity difference $s \equiv |z_1 - z_2|$
- Firms produce imperfect substitutes and face a joint CES demand with unit expenditure:

$$\max_{q_{i1}, q_{i2}} \left(q_{i1}^{\frac{\sigma-1}{\sigma}} + q_{i2}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \quad \text{s.t. } p_{i1} q_{i1} + p_{i2} q_{i2} = 1$$

- Bertrand competition $\implies$ flow profits π_s are functions of the productivity gap s and not levels
  - homogeneous of degree zero with respect to productivity
- In the limiting case of perfect substitutes ($\sigma = \infty$),

$$\pi_{-s} = 0, \quad \pi_s = 1 - e^{-s}$$

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- Macro version: within-period consumer utility function $U(t) = \ln Y(t) - L(t)$;

$$\ln Y(t) = \int_0^1 \ln y(t;\nu)\, d\nu, \qquad y(t;\nu) = \left(q_{i1}(t;\nu)^{\frac{\sigma-1}{\sigma}} + q_{i2}(t;\nu)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}};$$

normalize prices so that the value of total output is one $P(t)\, Y(t) = 1$.

Model – dynamic block

- Firms invest in order to enhance market position
  - binary decision: incur cost c for Poisson rate η to gain productivity
- Given investments $\eta_s, \eta_{-s} \in \{0, \eta\}$, the state s evolves to

$$\begin{cases} s+1 & \text{with rate } \eta_s \\ s-1 & \text{with rate } (\eta_{-s} + \kappa) \end{cases}$$

- $\kappa < \eta$ is the exogenous rate of catching up
- Catch up is gradual: no leapfrogging
- Firms are forward-looking and maximize present-discounted-value v_s:

$$rv_s = \pi_s + (\eta_{-s} + \kappa)(v_{s-1} - v_s) + \max\{\eta(v_{s+1} - v_s) - c, 0\}$$

Symmetric MPE: collection of $\{\eta_s, v_s\}_{s=-\infty}^{\infty}$

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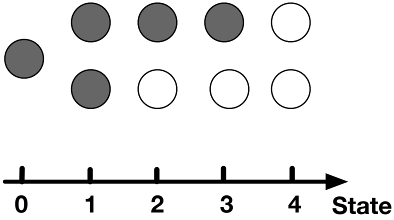
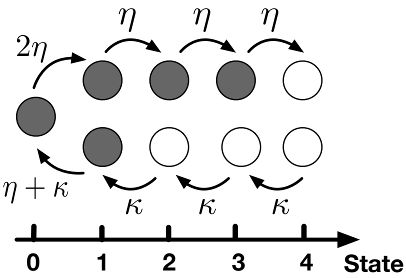


Symmetric MPE: collection of $\{\eta_s, v_s\}_{s=-\infty}^{\infty}$



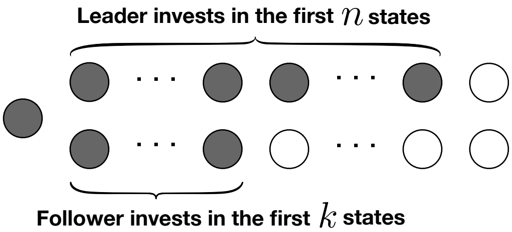
- Equilibrium induces steady-state distribution $\{\mu_s\}_{s=0}^{\infty}$ of market structure

$$\eta_s \mu_s = \left(\eta_{-(s+1)} + \kappa\right) \mu_{s+1}$$

- Aggregate productivity growth: the average growth rate across market structures

$$g \equiv \sum_{s=0}^{\infty} \mu_s \mathbb{E}\left[g_s\right]$$

Equilibrium structure: leader dominance

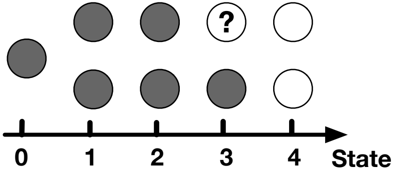


Lemma. Leader invests (weakly) more than the follower does.

Equilibrium structure: leader dominance

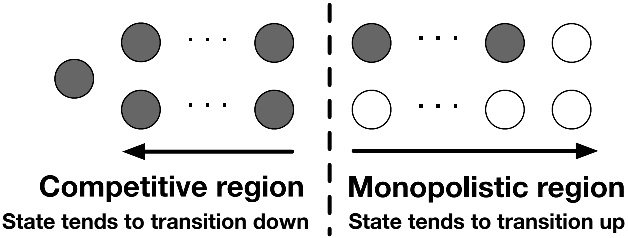
Leader cannot stop investing first—proof by contradiction

- transient monopoly power $\implies$ follower incentive has to be low

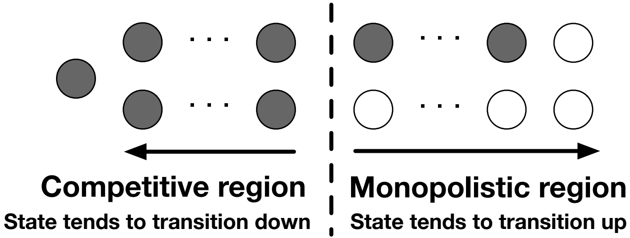


Show value functions

Steady-state, two regions, and growth



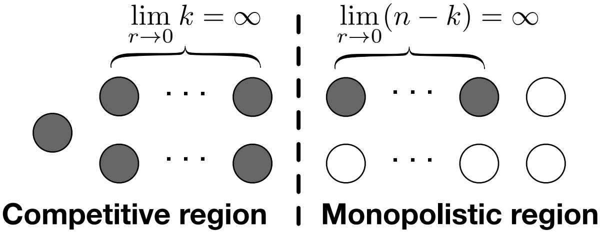
Steady-state, two regions, and growth



Lemma. In a steady state, productivity growth rate and aggregate investment are **increasing** in the fraction of markets in the competitive region and **decreasing** in the fraction of markets in the monopolistic region:

$$\frac{g}{\ln \lambda} = \underbrace{\left(\sum_{s=1}^{k} \mu_s\right)}_{\text{fraction of markets in the competitive region}} \times (\eta + \kappa) + \underbrace{\left(\sum_{s=k+1}^{n+1} \mu_s\right)}_{\text{fraction of markets in the monopolistic region}} \times \kappa.$$

As $r \to 0$, both regions expand indefinitely

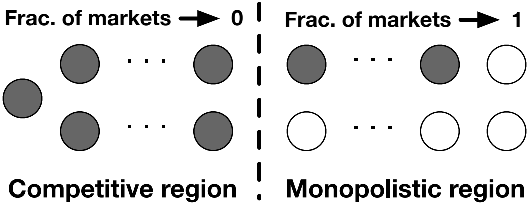


- Traditional expansionary effect: low interest rate raises investments in all states

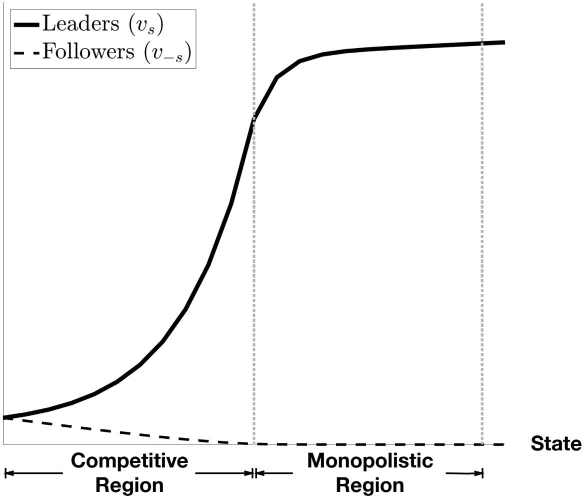
As $r \to 0$, the monopolistic region dominates

Proposition. As $r \to 0$:

1. The monopolistic region becomes **absorbing**: $\sum_{s=k+1}^{n+1} \mu_s \to 1$;
2. Monopoly power becomes **permanently persistent**;
3. Productivity gap between leaders and followers **diverges**: $\lim_{r \to 0} \sum_{s=0}^{\infty} \mu_s s = \infty$;
4. Aggregate investment drops and productivity growth **slows down**: $\lim_{r \to 0} g = \kappa \cdot \ln \lambda$.



Value functions and intuition



$$\lim_{r \to 0} r v_n > 0, \qquad \lim_{r \to 0} r v_0 = 0,$$

$$\lim_{r \to 0} r \left(v_{k+1} - v_k \right) > 0.$$

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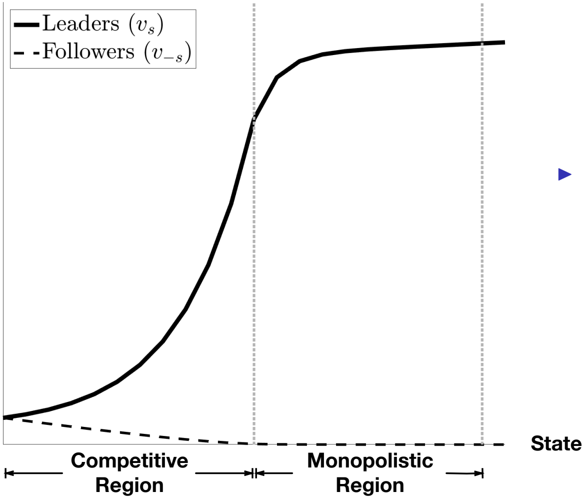

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- Leader:
  - falling to the competitive region is costly
  - keeps investing to ensure such probability is vanishingly small

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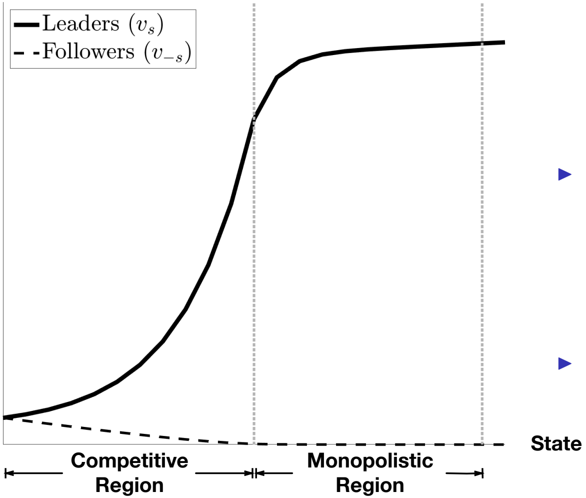

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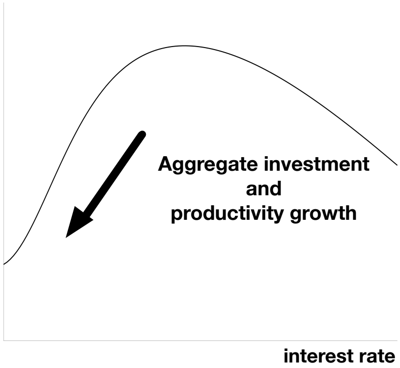
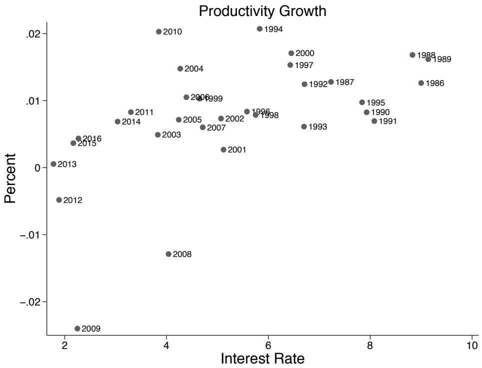
- Leader:
  - falling to the competitive region is costly
  - keeps investing to ensure such probability is vanishingly small
- Follower:
  - leadership is (endogenously) unattainable
  - gives up despite being patient

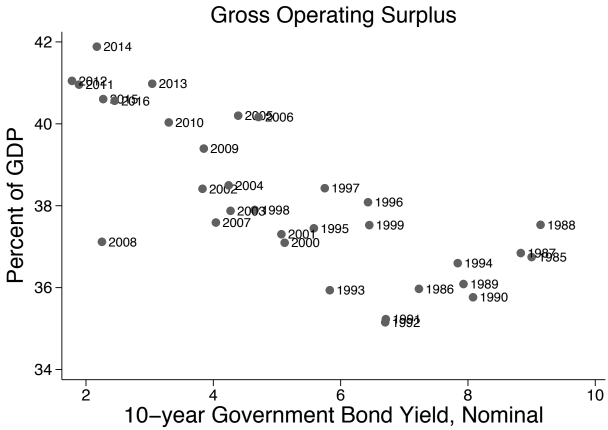
Steady-state implication 1: slowdown in productivity growth





- Secular stagnation literature: level vs growth; demand vs supply;
- Cette, Fernald, Mojon (2015)
- Gutierrez and Philippon (2016, 2017), Lee, Stulz, and Shin (2017): sharp decline of investment relative to operating surplus; investment gap is especially pronounced in concentrated industries

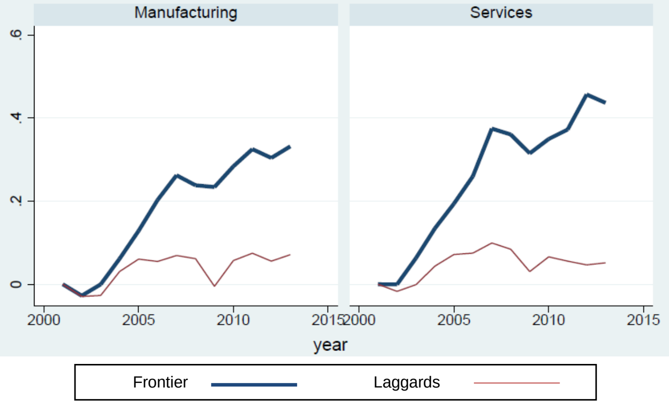
Steady-state implication 2: rise in profits and concentration



De Loecker and Eeckhout (2017), Barkai (2017), Autor et al. (2017), Gutierrez and Philippon (2016, 2017), Grullon, Larkin, Michaely (2017)

Steady-state implication 3: widening productivity gap

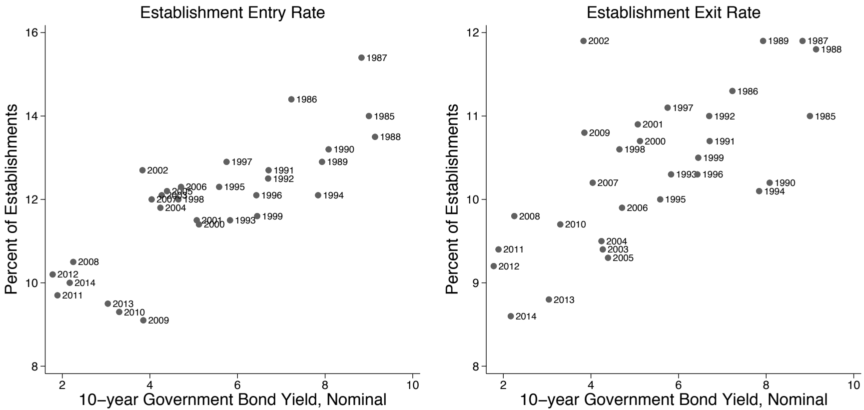
Labour productivity: value added per worker (2001-2013)



Andrews, Criscuolo, Gal (2016):

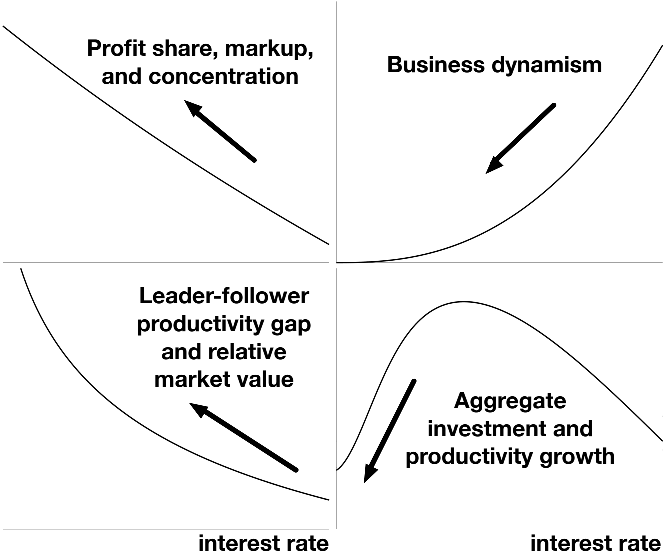
- productivity gap is widening over time for OECD countries
- slow down in productivity convergence

Steady-state implication 4: decline in business dynamism

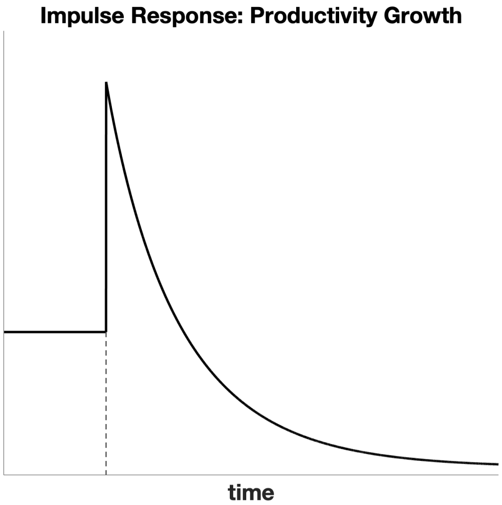


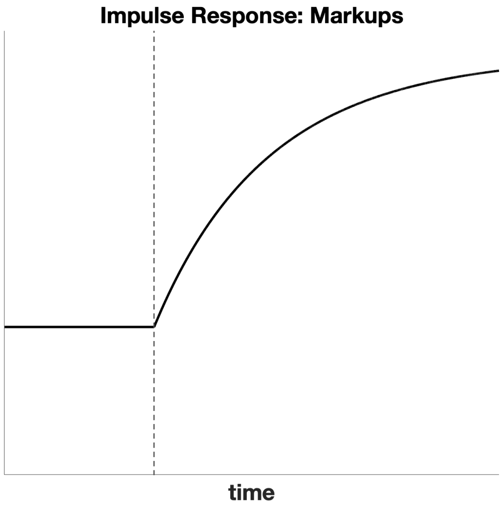
Davis and Haltiwanger (2014), Decker et al. (2014), Haltiwanger (2015), Hathaway and Litan (2015), Andrews, Criscuolo, and Gal (2016)

Summary: low interest rates are consistent with many stylized facts

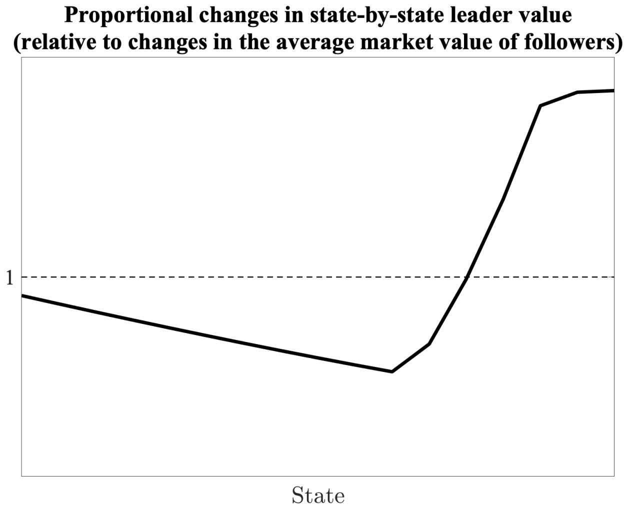


Transitional dynamics: growth and markups





On-impact asymmetric valuation effect



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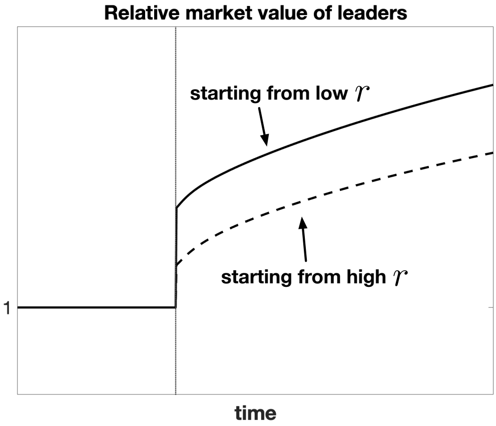

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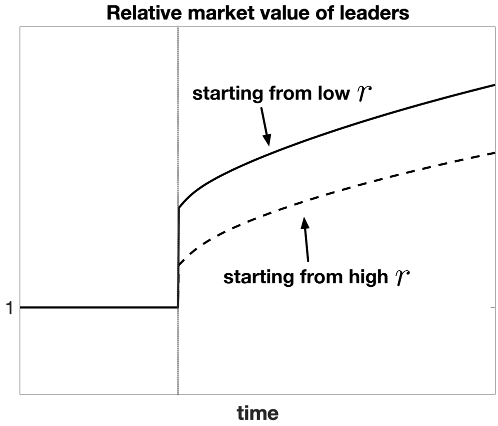

Proposition. Consider a decline in the interest rate $-\Delta r$. On impact, as a first-order approximation around $r \approx 0$,

$$-\frac{\Delta V^L}{\Delta r} = \frac{1}{r} \quad \text{and} \quad -\frac{\Delta V^F}{\Delta r} = -\frac{1}{r \ln r}.$$

- Starting from a low r, a further decline in r will
  - immediately benefit leaders relative to followers (leaders have longer duration)
  - especially when initial r is low (leaders have higher convexity)

Empirical test: long-short portfolio

- Prediction: a decline in interest rate
  - benefits leaders more than followers
  - especially when the level of interest rate is low

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- Data: Compustat, CRSP, 10-year treasury yield, 1980-2017

- Specification:

$$R_t = \alpha + \beta_0 \cdot i_{t-1} + \beta_1 \cdot \Delta i_t + \beta_2 \cdot \Delta i_t \cdot i_{t-1} + \text{controls}_t + \epsilon_t$$

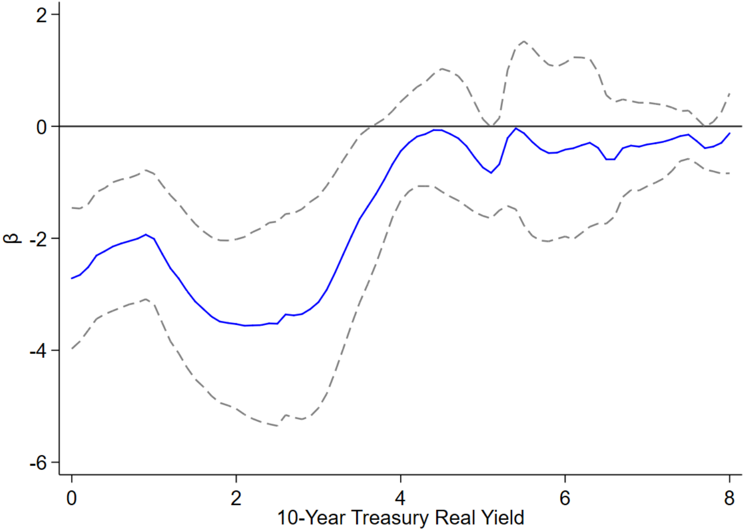
  - R_t: 90-day return of a value-weighted long-short portfolio
  - Leaders defined as top 5% by marketcap within Fama-French industries
    - robust to various other specifications: SIC, top 5, EBITDA, sales

Empirical test: long-short portfolio

	Portfolio Return		
	(1)	(2)	(3)
Δi_t	-1.150^{***}	-3.819^{***}	-2.268^{***}
	(0.309)	(0.641)	(0.602)
$\Delta i_t \cdot i_{t-1}$		0.294^{***}	0.117^{*}
		(0.059)	(0.056)
Controls	N	N	Y
# Obs.	9,016	9,016	9,016
adj. R^2	0.044	0.089	0.228

- Market leaders exhibit relative valuation gains following declines in r
  - effect especially strong under low r
  - not driven by leverage, HML, cyclicality, P/E ratio
- Return of "leader-portfolio" correlates negatively with "P/E portfolio"

Leaders see higher returns from $-\Delta i$ when i is low



Conclusion

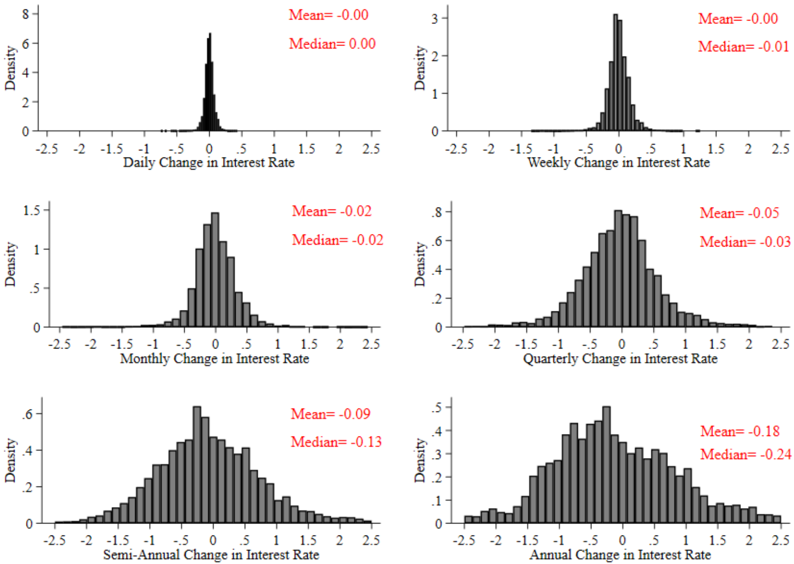
- Low interest rates raise market concentration and reduce creative destruction
  - through strategic and dynamic incentives
  - as $r \to 0$, aggregate investment and growth slows down
    - $g(r)$ has the shape of an inverted-U
  - empirical tests confirm predictions
- A long-run, supply-side perspective of secular stagnation
  - sidestepping short-run, demand-side Keynesian forces
- Developed techniques to analyze asymptotic equilibria of strategic patent races

Appendices

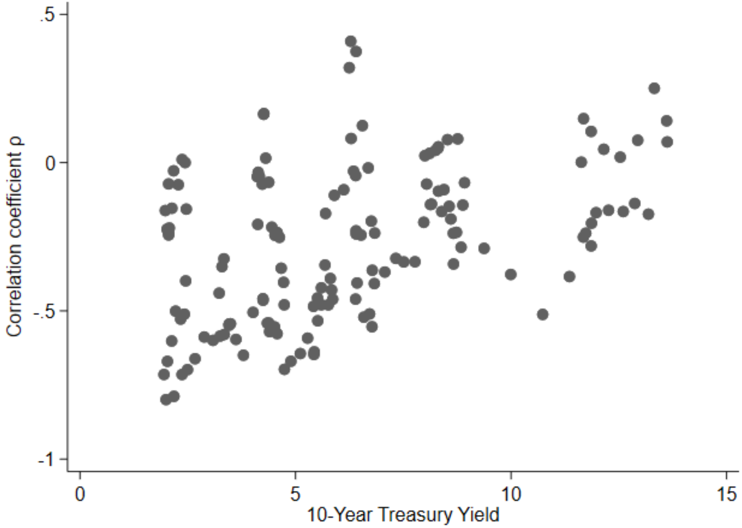
- Distribution of interest rate changes at varying frequencies
- Regression: nonparametric visualization
- Panel regressions
- Portfolio test: full specifications
- Portfolio test: along the yield curve

Distribution of interest rate changes at varying frequencies

Back



Leaders see higher returns from Δi when i is low Back



Testing asymmetric effects: panel specification Back

	Stock Return			
	(1)	(2)	(3)	(4)
Top 5 Percent=1 x Δi	-1.187***	-3.881**	-4.415***	-4.182***
	(0.260)	(1.113)	(0.893)	(0.529)
Top 5 Percent=1 x Δi x Lagged i		0.293**	0.346***	0.301***
		(0.095)	(0.079)	(0.045)
Firm β x Δi				14.10***
				(0.795)
Firm β x Δi x Lagged i				-1.260***
				(0.082)
Sample	All	All	All	All
Controls	N	N	Y	
Industry-Date FE	Y	Y	Y	Y
N	61,313,604	61,313,604	44,104,181	61,299,546
R-sq	0.403	0.403	0.415	0.409

Empirical test: long-short portfolio, full specification Back

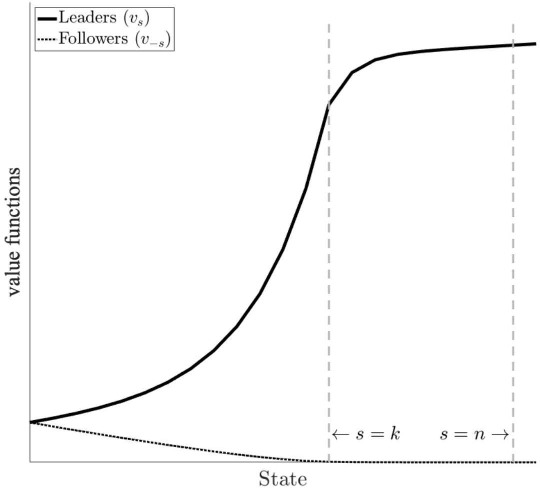
	Portfolio Return				
	(1)	(2)	(3)	(4)	(5)
Δi_t	-1.150***	-3.819***	-2.268***	-3.657***	-3.001***
	(0.309)	(0.641)	(0.602)	(0.949)	(0.720)
i_{t-1}		0.0842	0.0336	0.160*	0.167*
		(0.050)	(0.044)	(0.071)	(0.069)
$\Delta i_t \times i_{t-1}$		0.294***	0.117*	0.328***	0.239*
		(0.059)	(0.056)	(0.081)	(0.096)
Excess Market Return			-0.168***		
			(0.023)		
High Minus Low			0.0371		
			(0.044)		
$(\Delta i_t > 0)$=1 $\times$ Δi_t				0.341	
				(1.717)	
$(\Delta i_t > 0)$=1 $\times$ $\Delta i_t \times i_{t-1}$				-0.102	
				(0.170)	
PE Portfolio Return					-0.207***
					(0.059)
N	9,016	9,016	9,016	9,016	7,402
R-sq	0.044	0.089	0.228	0.092	0.196

Empirical test: long-short portfolio, along the yield curve Back

	30-Year		2-Year		10-30 Forward		2-Year & 10-30 Fwd.	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Δi_t	-1.129**	-4.537***						
	(0.348)	(0.826)						
$\Delta i_t \times i_{t-1}$		0.362***						
		(0.077)						
$\Delta i_{t,0,2}$			-0.584*	-3.535***			-0.126	-2.066*
			(0.244)	(0.833)			(0.349)	(0.970)
$\Delta i_{t,0,2} \times i_{t-1}$				0.280***				0.145
				(0.069)				(0.080)
$\Delta i_{t,10,30}$					-1.084**	-4.165***	-0.938	-3.138**
					(0.354)	(0.835)	(0.523)	(1.043)
$\Delta i_{t,10,30} \times i_{t-1}$						0.334***		0.289**
						(0.080)		(0.107)
N	8,006	8,006	8,065	8,065	8,006	8,006	8,006	8,006
R-sq	0.036	0.078	0.021	0.063	0.030	0.066	0.031	0.084

Value functions and leader dominance

Back



- Joint profits are increasing in the state:

$$v_s + v_{-s} > v_{s-1} + v_{-(s-1)}$$

$$\Longrightarrow \quad v_s - v_{s-1} > v_{-(s-1)} - v_{-s}$$

  - this implies that $n \geq k - 1$
  - $n \geq k$ follows from the persistence of leadership in state $k + 1$