

# Low Interest Rates, Market Power, and Productivity Growth

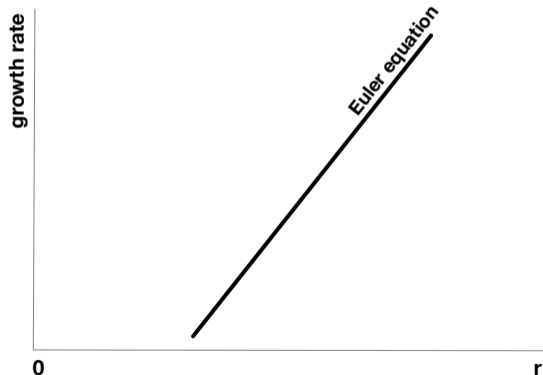
Ernest Liu, Atif Mian, and Amir Sufi

# 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

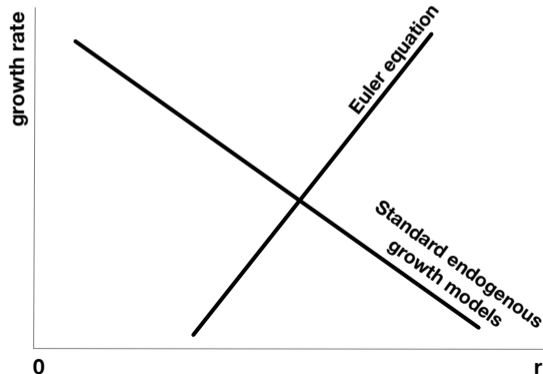
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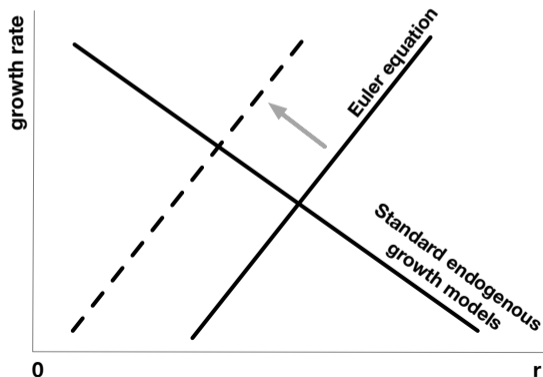
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- ▶ Very low interest rate  $r \rightarrow 0$  is guaranteed to be contractionary
  - no financial frictions or Keynesian forces



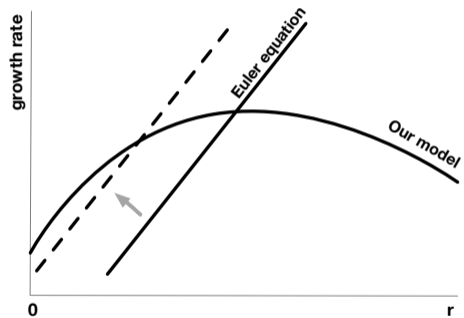
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Intuitions: under low  $r$ , firms are effectively more “patient”

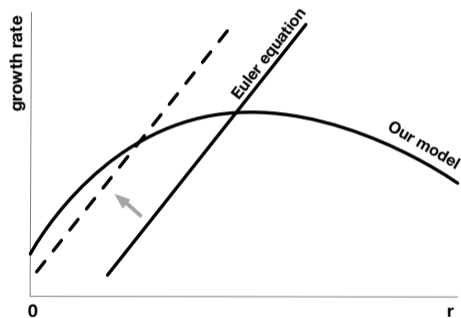
- ▶ For the leader, small prospect of being caught up implies large change in value
- ▶ For the follower, low rates motivate investment only if future profits are attainable
  - market leadership becomes *endogenously unattainable* for the follower

## Model predictions



►  $g(r)$  has an inverted-U shape

# Model predictions



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Other steady-state predictions as  $r$  declines:

- ▶ ↗ profit share, markups, concentration, leader-follower productivity gap
- ▶ ↘ 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  $s \in \{0, 1, \dots, \infty\}$ : 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  $\pi_s$ ,  $-\pi_{-s}$ , 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  $\lambda^{-z}$ 
  - 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:

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

- ▶ Bertrand competition  $\implies$  flow profits  $\pi_s$  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 ( $\sigma = \infty$ ),

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

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

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  $\eta$  to gain productivity
- ▶ Given investments  $\eta_s, \eta_{-s} \in \{0, \eta\}$ , the state  $s$  evolves to

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

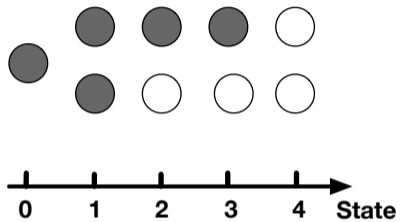
- ▶  $\kappa < \eta$  is the exogenous rate of catching up
- ▶ Catch up is gradual: no leapfrogging
- ▶ Firms are forward-looking and maximize present-discounted-value  $v_s$ :

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

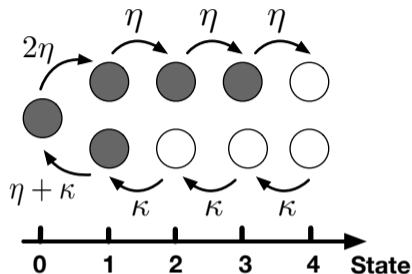
Symmetric MPE: collection of  $\{\eta_s, v_s\}_{s=-\infty}^{\infty}$



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



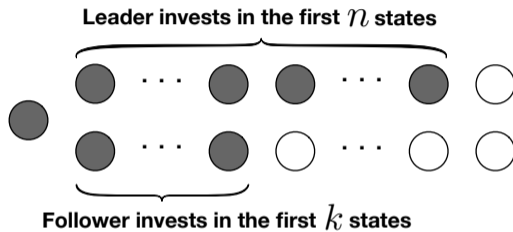
- ▶ Equilibrium induces steady-state distribution  $\{\mu_s\}_{s=0}^{\infty}$  of market structure

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

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

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

## Equilibrium structure: leader dominance

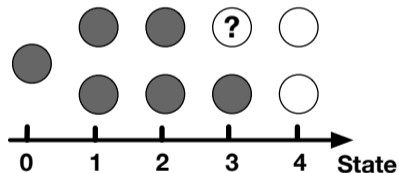


**Lemma.** Leader invests (weakly) more than the follower does.

## Equilibrium structure: leader dominance

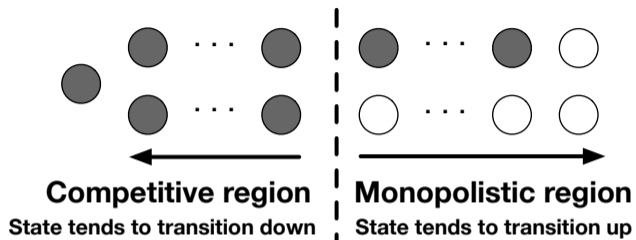
Leader cannot stop investing first—proof by contradiction

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

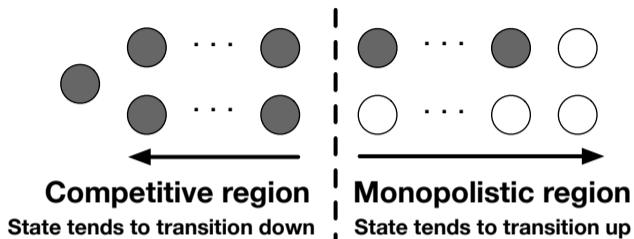


Show value functions

## Steady-state, two regions, and growth



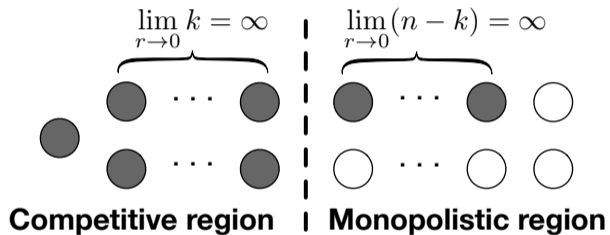
## Steady-state, two regions, and growth



**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  $r \rightarrow 0$ , both regions expand indefinitely

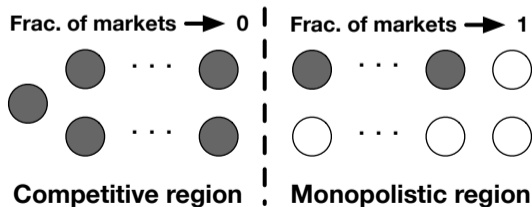


- ▶ Traditional expansionary effect: low interest rate raises investments in all states

## As $r \rightarrow 0$ , the monopolistic region dominates

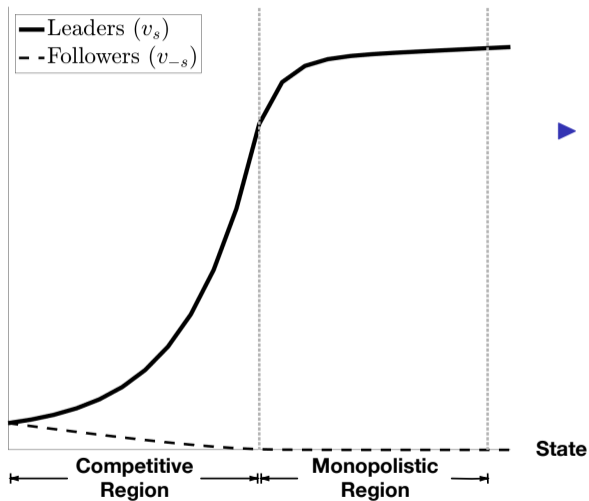
**Proposition.** As  $r \rightarrow 0$ :

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





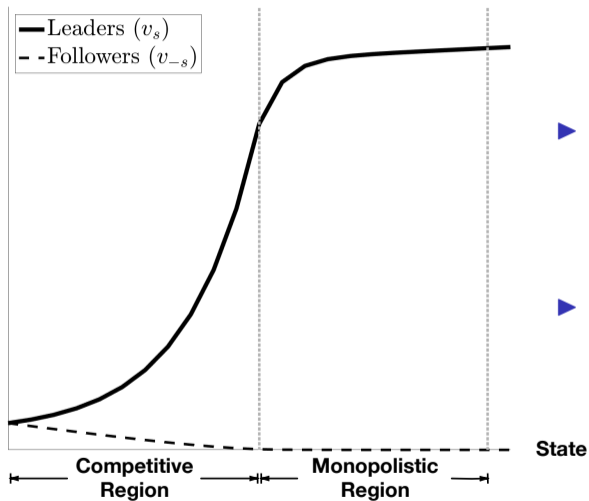
# Value functions and intuition



► Leader:

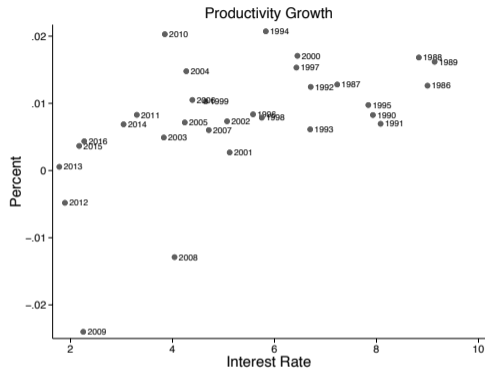
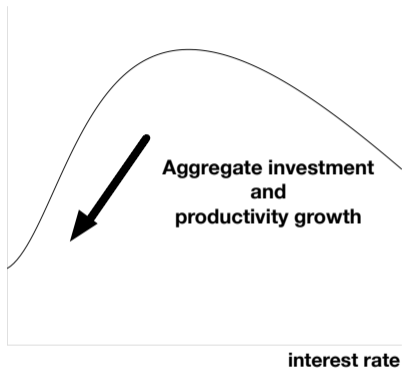
- falling to the competitive region is costly
- keeps investing to ensure such probability is vanishingly small

# Value functions and intuition



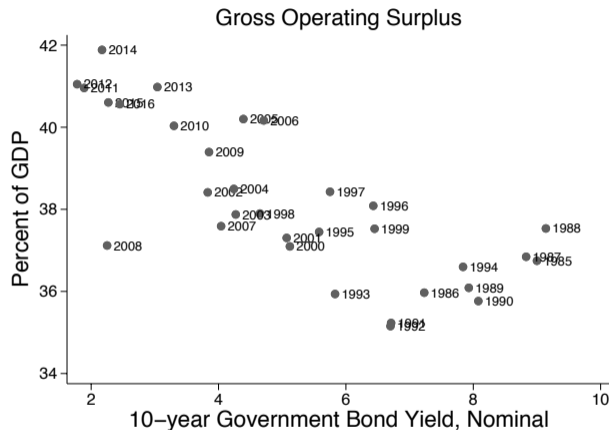
- ▶ Leader:
  - falling to the competitive region is costly
  - keeps investing to ensure such probability is vanishingly small
- ▶ Follower:
  - leadership is (endogenously) unattainable
  - gives up despite being patient

# Steady-state implication 1: slowdown in productivity growth



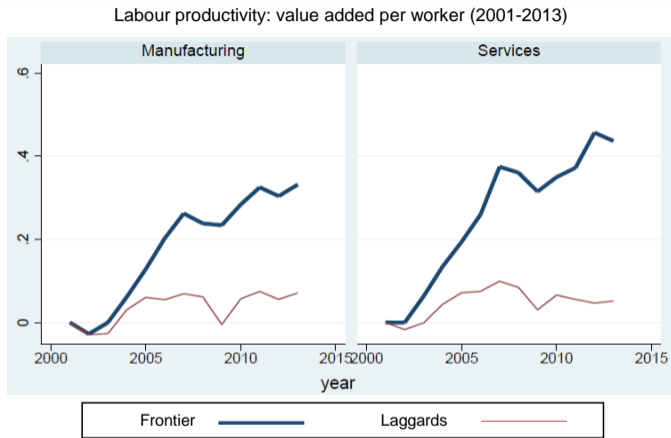
- ▶ Secular stagnation literature: level vs growth; demand vs supply;
- ▶ Cetto, Fernald, Mojon (2015)
- ▶ Gutierrez and Philippon (2016, 2017), Lee, Stulz, and Shin (2017): sharp decline of investment relative to operating surplus; investment gap is especially pronounced in concentrated industries

## 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)

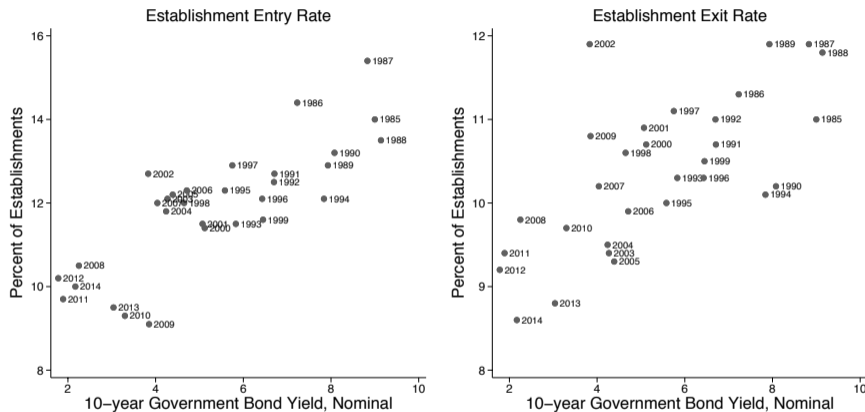
## Steady-state implication 3: widening productivity gap



Andrews, Criscuolo, Gal (2016):

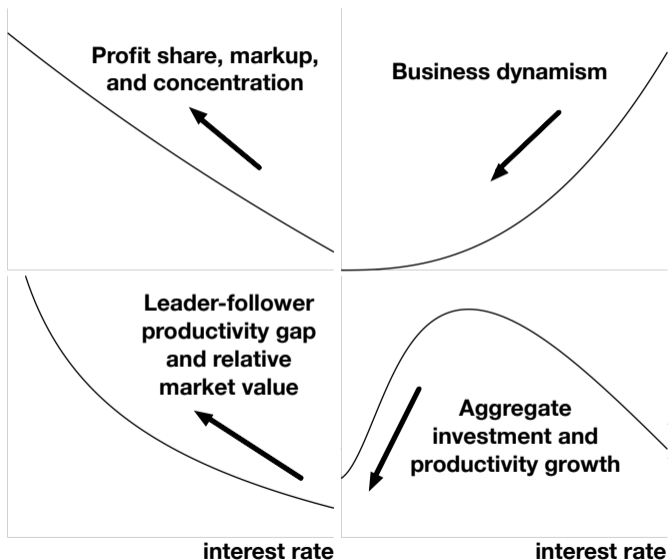
- ▶ productivity gap is widening over time for OECD countries
- ▶ slow down in productivity convergence

## 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



## Empirical test based on valuation effects

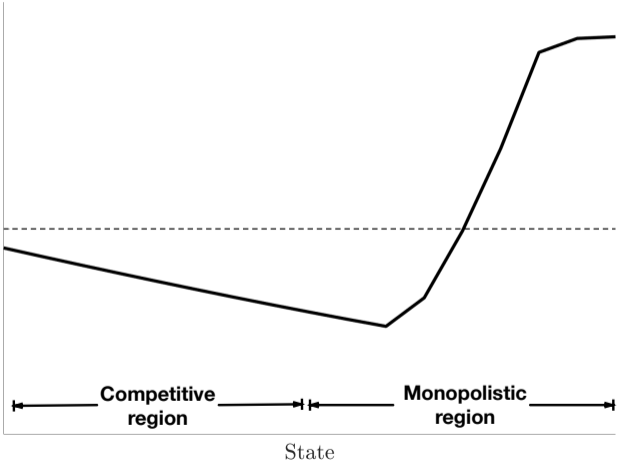
- ▶ Outcome variables such as market concentration and productivity growth are slow moving, examining valuation effects provide statistically powerful test of the theory
- ▶ Key object of analysis:  $\frac{\Delta V^L}{\Delta r}$  and  $\frac{\Delta V^F}{\Delta r}$ , which are the on impact valuation effects of the leader and follower from a change in the interest rate

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

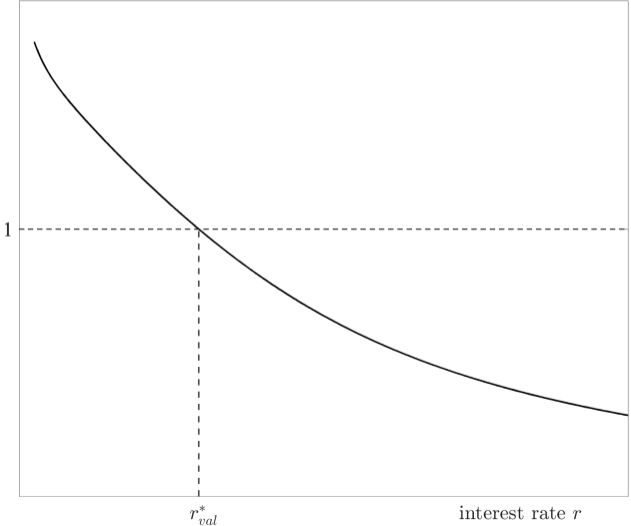
$$-\frac{\Delta V^L}{\Delta r} = \frac{1}{r} \quad \text{and} \quad -\frac{\Delta V^F}{\Delta r} = -\frac{1}{r \ln r}.$$



# On-impact asymmetric valuation effect: state-by-state



# On-impact asymmetric valuation effect: in aggregate



## Testing asymmetric effects: panel specification

$$R_{i,j,t} = \alpha_{j,t} + \beta_0 D_{i,j,t-1} + \beta_1 D_{i,j,t-1} \times \Delta i_t + \beta_2 D_{i,j,t-1} \times i_{t-1} + \beta_3 D_{i,j,t-1} \times \Delta i_t \times i_{t-1} + \epsilon_{i,j,t}$$

	Stock Return			
	(1)	(2)	(3)	(4)
Top 5 Percent=1 $\times \Delta i$	-1.187*** (0.260)	-3.881** (1.113)	-4.415*** (0.893)	-4.182*** (0.529)
Top 5 Percent=1 $\times \Delta i \times$ Lagged $i$		0.293** (0.095)	0.346*** (0.079)	0.301*** (0.045)
Firm $\beta \times \Delta i$				14.10*** (0.795)
Firm $\beta \times \Delta i \times$ Lagged $i$				-1.260*** (0.082)
Sample	All	All	All	All
Controls	N	N	Y	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

$$R_t = \alpha + \beta_0 i_{t-1} + \beta_1 \Delta i_t + \beta_2 \Delta i_t \times i_{t-1} + \epsilon_t$$

	Portfolio Return				
	(1)	(2)	(3)	(4)	(5)
$\Delta i_t$	-1.150*** (0.309)	-3.819*** (0.641)	-2.268*** (0.602)	-3.657*** (0.949)	-3.001*** (0.720)
$i_{t-1}$		0.0842 (0.050)	0.0336 (0.044)	0.160* (0.071)	0.167* (0.069)
$\Delta i_t \times i_{t-1}$		0.294*** (0.059)	0.117* (0.056)	0.328*** (0.081)	0.239* (0.096)
Excess Market Return			-0.168*** (0.023)		
High Minus Low			0.0371 (0.044)		
$(\Delta i_t > 0)=1 \times \Delta i_t$				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

# Conclusion

- ▶ Low interest rates raise market concentration and reduce creative destruction
  - through strategic and dynamic incentives
  - as  $r \rightarrow 0$ , 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