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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- What is the supply-side response to low interest rates?
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We find low rates near zero guaranteed to be contractionary

- A model of dynamic competition based on the patent race literature

- We find: a reduction in interest rate has an "anti-competitive" effect
- Raises market concentration and profits
- Causes market power to become more persistent

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

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
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Model predictions

\( g(r) \) has an inverted-U shape
Other steady-state predictions as $r$ declines:

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

Short-run predictions:

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

$g(r)$ has an inverted-U shape
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 $\pi_s$, $-\pi_{-s}$, 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 = |z_1 - z_2|
- Firms produce imperfect substitutes and face a joint CES demand with unit expenditure:
  
  $$\max_{q_{i1}, q_{i2}} \left( \frac{\sigma - 1}{\sigma} q_{i1}^\sigma + \frac{\sigma - 1}{\sigma} q_{i2}^\sigma \right)^\frac{\sigma}{\sigma - 1} \quad \text{s.t. } p_{i1} q_{i1} + p_{i2} q_{i2} = 1$$

- 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 ($\sigma = \infty$),
  
  $$\pi_{-s} = 0, \quad \pi_s = 1 - e^{-s}$$
Microfoundation for the static block

- Firm with productivity $z$ has marginal cost of production $\lambda^{-z}$
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  \[
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  \]
- 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 $P(t) Y(t) = 1$. 
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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- 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
Steady-state, two regions, and growth

- **Competitive region**: State tends to transition down
- **Monopolistic region**: State tends to transition up

\[ \frac{\text{fraction of markets in the competitive region}}{\lambda} \approx \frac{1}{\mu(k_1 + \kappa)} \]
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:

\[
\frac{g}{\ln \lambda} = \left( \sum_{s=1}^{k} \mu_s \right) \times (\eta + \kappa) + \left( \sum_{s=k+1}^{n+1} \mu_s \right) \times \kappa.
\]

- **Competitive region**: State tends to transition down
- **Monopolistic region**: State tends to transition up
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

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;
- 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

Steady-state implication 3: widening productivity gap

- productivity gap is widening over time for OECD countries
- slow down in productivity convergence
Steady-state implication 4: decline in business dynamism

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

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

<table>
<thead>
<tr>
<th>Stock Return</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
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<tbody>
<tr>
<td>Top 5 Percent=1 x (\Delta i)</td>
<td>-1.187***</td>
<td>-3.881**</td>
<td>-4.415***</td>
<td>-4.182***</td>
</tr>
<tr>
<td>(\Delta i)</td>
<td>(0.260)</td>
<td>(1.113)</td>
<td>(0.893)</td>
<td>(0.529)</td>
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<tr>
<td>Top 5 Percent=1 x (\Delta i) x Lagged (i)</td>
<td>0.293**</td>
<td>0.346***</td>
<td>0.301***</td>
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<tr>
<td>(\Delta i) x Lagged (i)</td>
<td>(0.095)</td>
<td>(0.079)</td>
<td>(0.045)</td>
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<tr>
<td>Firm (\beta \times \Delta i)</td>
<td></td>
<td></td>
<td></td>
<td>14.10***</td>
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<tr>
<td>(\Delta i)</td>
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<td>(0.795)</td>
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<tr>
<td>Firm (\beta \times \Delta i) x Lagged (i)</td>
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<td></td>
<td>-1.260***</td>
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<tr>
<td>(\Delta i) x Lagged (i)</td>
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<td>(0.082)</td>
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<table>
<thead>
<tr>
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<tr>
<td>Controls</td>
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<td>N</td>
<td>Y</td>
<td></td>
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<tr>
<td>Industry-Date FE</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
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<tr>
<td>N</td>
<td>61,313,604</td>
<td>61,313,604</td>
<td>44,104,181</td>
<td>61,299,546</td>
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<tr>
<td>R-sq</td>
<td>0.403</td>
<td>0.403</td>
<td>0.415</td>
<td>0.409</td>
</tr>
</tbody>
</table>
Empirical test: long-short portfolio, full specification

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

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