Low Interest Rates, Market Power, and Productivity Growth by Liu et al. (2022)

Shengyu Li

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Introduction

- RQ: investigate the effect of a decline in interest rates on investments in productivity enhancement when firms engage in dynamic strategic competition.
- Main contribution: use dynamic strategic competition theory to explain the secular trends – declining interest rate, rising market concentration, widening productivity gap, and falling productivity growth.
  - Tradition effect: $r \downarrow$, more investment by market leader and followers.
  - Strategic effect: market leaders invest more aggressively relative to market follower when $r \downarrow$

Main Mechanism

- When r is low, the present value of a persistent market leader becomes high.
- The attraction of becoming a persistent leader generates fierce competition especially if two firms are close to one another in the technological ladder.
- The realization that competition will become more vicious if the leader and follower become closer discourages the follower while encouraging the leader.
  - Market leaders invest more aggressively in an attempt to ensure they avoid neck-and-neck competition.
  - Market followers, understanding that the competition is more fierce when that get closer, become discouraged and invest less aggressively.

A Stylized Model

- Two firms compete in an industry. There is a technological ladder.
- An industry has only three states:
  - Firms compete neck-and-neck (state 0): $\pi_0 = 1/2$;
  - They are one step apart: $\pi_1 = 1$ and $\pi_{-1} = 0$;
  - They are two steps apart: $\pi_2 = 1$ and $\pi_{-2} = 0$

  If firms are two steps apart, the state becomes permanent.
- Firms compete in the rate of investment in R&D,η, with cost $c(\eta) = -\eta^2/2$.
- Innovation, which make them advance one step ahead on the technological ladder, arrives with Poisson rate η.

A Stylized Model

- The value of a permanent leader and followers are $v_2 = 1/r$ and $v_{-2} = 0$.
- The firm values in other state satisfy

$$rv_1 = \max_{\eta} \pi_1 - \frac{\eta^2}{2} + \eta(v_2 - v_1) + \eta_{-1}(v_0 - v_1) \tag{1}$$

$$rv_{-1} = \max_{\eta} \pi_{-1} - \frac{\eta^2}{2} + \eta(v_0 - v_{-1}) + \eta_1(v_{-2} - v_{-1}) \tag{2}$$

$$rv_0 = \max_{\eta} \pi_0 - \frac{\eta^2}{2} + \eta(v_1 - v_0) + \eta_0(v_{-1} - v_0) \tag{3}$$

- FOCs: $\eta_1 = v_2 - v_1$ and $\eta_{-1} = v_0 - v_{-1}$
  - The follower gains value from reaching state 0 so it has a chance to become the leader in the future;
  - The leader gains value from reaching to state 2 not because of higher flow profits (note $\pi_1 = \pi_2 = 1$) but by turing its temporary leadership into a permanent one.

Mechanism

What happens to η_1 and η_{-1} if there is a fall in interest rate r? η_1 rises by more than η_{-1} as r falls.

- Leader: v_2 (the net present value of its monopoly profits) is higher when r is lower.
- Follower: The gain from a fall in r (i.e. v_0) is not as high due to the endogenous response of its competitor in state 0 were the follower to successfully innovate.
- A fall in r makes firms compete more fiercely in state 0. Asymmetric response:
  - The expectation of a more fierce competition in future state 0 disincentivizes the follower from catching up.
  - The possibility of escaping the fierce competition raises the incentive for the leader.

Model: Intratemporal Competition

- A continuum of duopoly markets. Bertrand competition:

$$\max_{p_i}(p_i - \lambda^{-z_i})y_i \quad \text{s.t. } p_1y_1 + p_2y_2 = 1, \frac{y_1}{y_2} = \left(\frac{p_1}{p_2}\right)^{-\sigma}$$

- A higher productivity gap ($s = |z_1 - z_2|$): higher π_s, lower π_{-s} and higher $\pi_s + \pi_{-s}$.
- Markets with higher productivity gap is more concentrated.

Model: Investment Choice

- Cost $c(\eta_s)$, η_s Poisson rate to improve its productivity by one step.

$$s(t+dt) = \begin{cases} s(t)+1 & \text{with probability } \eta_s dt \\ s(t)-1 & \text{with probability } (\eta_{-s}+\kappa)dt \\ s(t) & \text{otherwise} \end{cases}$$

  κ: exogenous catch-up rate for the follower.

- Value functions:

$$rv_s = \max_{\eta} \pi_s - c(\eta) + \eta(v_{s+1} - v_s) + \eta_{-s}(v_{s-1} - v_s) \tag{4}$$

$$rv_{-s} = \max_{\eta} \pi_{-s} - c(\eta) + \eta(v_{-(s-1)} - v_{-s}) + \eta_s(v_{-(s+1)} - v_{-s}) \tag{5}$$

$$rv_0 = \max_{\eta} \pi_0 - c(\eta) + \eta(v_1 - v_0) + \eta_0(v_{-1} - v_0) \tag{6}$$

Model: Aggregate over Markets

- The distribution of productivity gaps in the entire economy is denoted by $\{\mu_s\}_{s=0}^{\infty}$
- The steady state equilibrium: the density of each productivity gap is time invariant.

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

$$\mu_0\eta_0 = \mu_1(\eta_{-1}+\kappa)$$

- Aggregative productivity: total production cost. The growth rate is

$$g = \ln\lambda \sum_{s=0}^{\infty} \mu_s\eta_s = \ln\lambda \sum_{s=1}^{\infty} \mu_s(\eta_{-s}+\kappa)$$

Analytical Solution Assumption

- For an analytical solution, the cost function is linear: $c(\eta_s) = c\eta_s$ for $\eta_s \in [0, \eta]$.
- Investment is a binary decision: $\eta_S \in \{0, \eta\}$.

Results: Investment Cutoff, States n and k

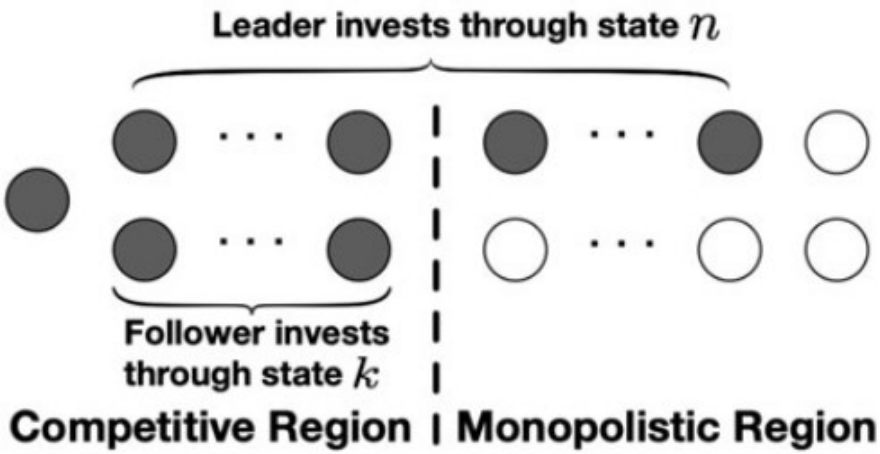

FIGURE 1.—Illustration of Equilibrium Structure.

- Competition region: productivity gap widens with rate η and narrows with rate $\eta + \kappa$
- Monopolistic region: widens with rate η and narrows with rate κ

Reasons to stop investment:

- Followers: "discouragement effect". It is too far behind and the marginal value of catching up by one step is low.
- Leaders: "lazy monopolist effect". The value of additional step of security in monopolistic region is low.

Results: Value Function

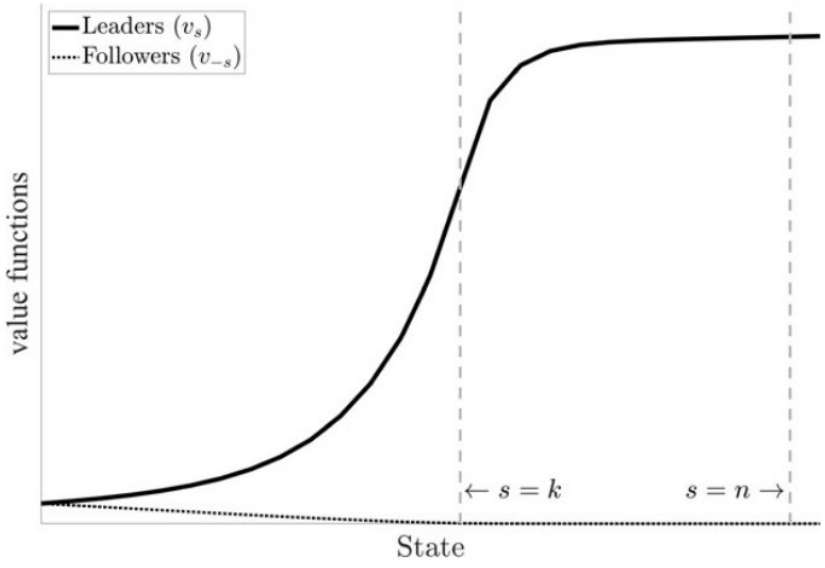

FIGURE 2.—Value functions.

- The leader's incentive to invest is always higher than the follower's incentive: for any $s < n$

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

- Reason: the competition in state $s-1$ is more fierce than state s (slides 6) $\rightarrow$ a deterrence to the follower.

Results: Steady State

$$g = \ln \lambda(\mu^C(\eta + \kappa) + \mu^M \kappa), \quad \mu^C = \sum_{s=1}^{k} \mu_s,\ \mu^M = \sum_{s=k+1}^{n+1} \mu_s$$

$$\mu^C + \mu^M + \mu_0 = 1$$

- Holding n constant, a higher k raises the productivity growth rate;
- Holding $k \geq 1$ constant, a higher n reduces productivity growth rate.

Comparative Steady State: Declining Interest Rate

A decline in the interest rate not only affects the investment decisions in each state, but also shifts the steady-state distribution:

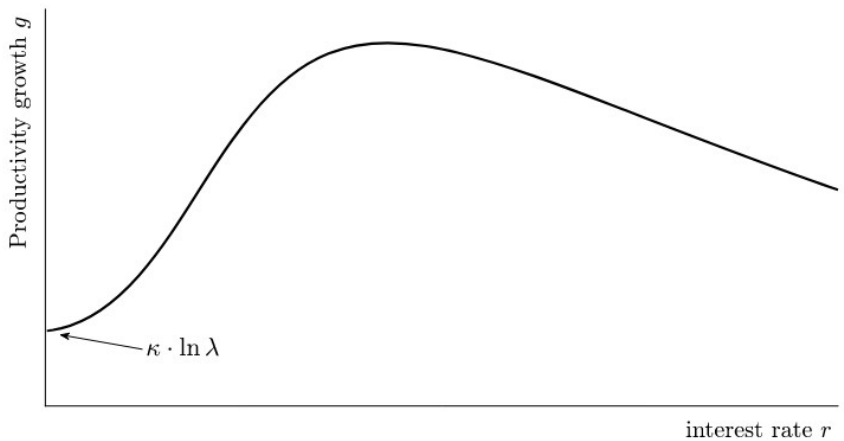

FIGURE 3.—Steady-state growth and the interest rate: inverted-U.

- With a lower r, firms in all states tend to invest more: both n and k increases when $r \to 0$
- The leader's investment response to a decline in r is stronger than follower's response: n increases larger with a decline in r than k .

Quantitative Results

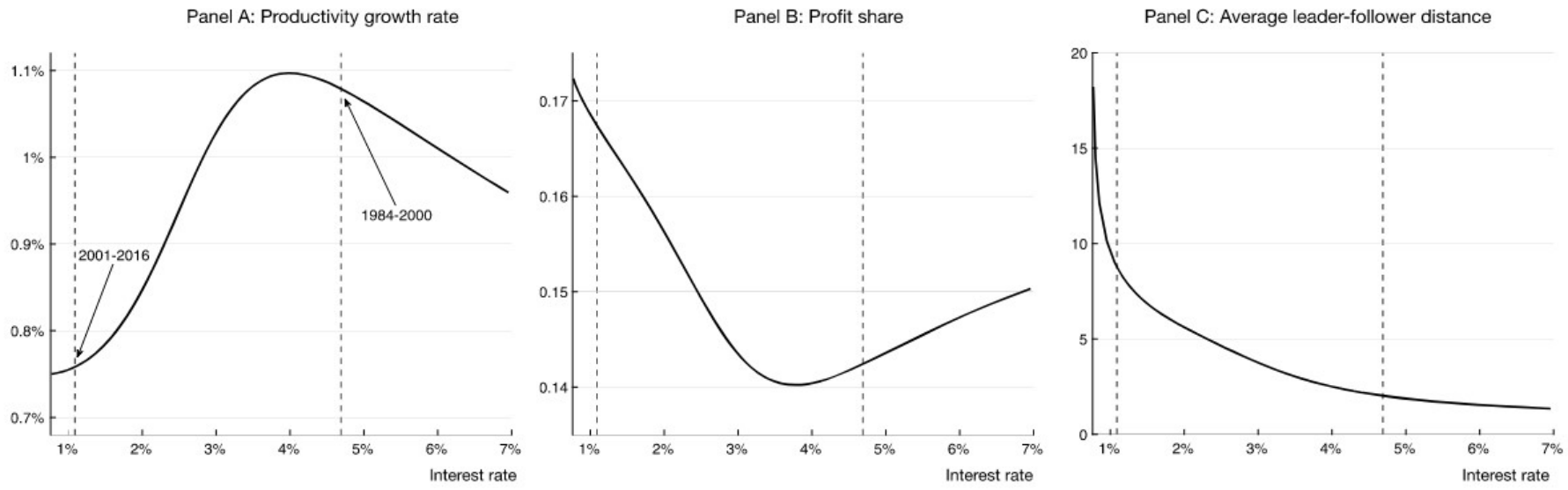

FIGURE 4.—Comparative steady states: low interest rates on productivity growth, profit share, and average leader-follower distance.

- Profit share: average profits net of investment cost relative to revenue across all firms.
- It is a measure of market competitiveness.

Policy Implications When r is Low

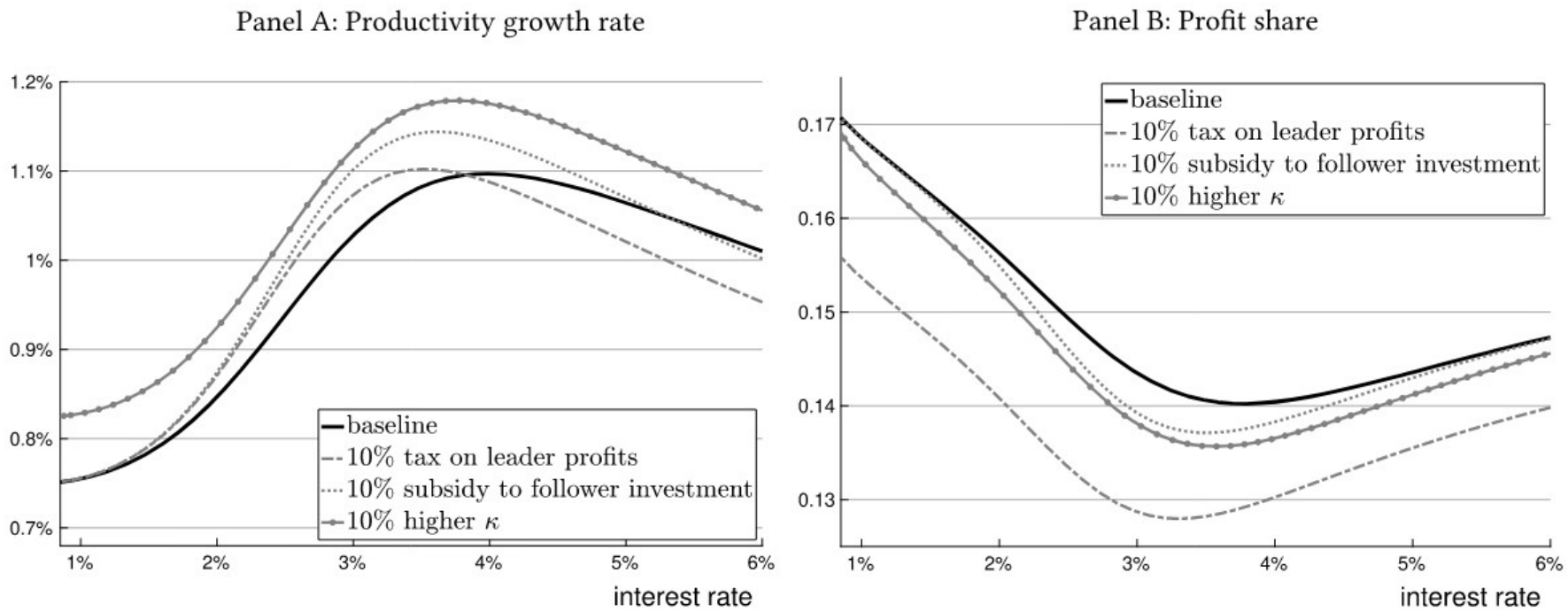

FIGURE 6.—Counterfactual productivity growth and profit share: (1) tax on leader profits, (2) subsidy to follower investment, and (3) higher κ.

- Policies targeted flow payment (tax or subsidy) are not effective.
- Policies which facilitate technological transfers from leaders to followers are effective.

Conclusion

- The paper explains the present trend across advanced economies: low interest rate, high market concentration, large productivity gaps and low productivity growth.
- When interest rate is low, market leaders aggressively invest to escape competition, whereas market followers become discouraged by the fierce competition that would be necessary to gain market leadership.

Reference I

Liu, E., Mian, A., and Sufi, A. (2022). Low interest rates, market power, and productivity growth. *Econometrica*, 90(1):193–221.