Falling Interest Rates and Credit Misallocation: Lessons from General Equilibrium

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Introduction

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- Conventional wisdom: declining interest rates stimulate economic activity.
- However, mounting concerns regarding their negative side-effects:
  - E.g. financial stability, innovation and growth.

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- Common perception: declining interest rates foster unproductive activities.
- Some suggestive evidence:
  - Recent credit booms characterized by low productivity growth
    Gopinath et al. 2017; Garcia-Santana et al 2020.
  - Low-interest rate environments characterized by "zombie" lending
    Banerjee and Hofmann 2018; Schivardi et al. 2020.
- Questions:
  - Do low interest rates foster (socially) unproductive activities?
  - Under what conditions?
  - Can this effect be strong enough to hamper economic activity and growth?
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- Key ingredients of the framework:
  - entrepreneurs borrow to invest in capital,
  - heterogeneous productivity,
  - financial constraints.
- Main insight: falling interest rates...
  - Prompt investment by less productive entrepreneurs,
  - Raise price of capital and crowd out more productive entrepreneurs.
  - Induced reallocation weakens expansionary effect:
    - Can be strong enough to reduce aggregate output!
    - Is inefficient due to excessive investment by less productive entrepreneurs.
    - Dynamically interacts with balance sheet channel → boom-bust dynamics of output.
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Related literature

- Credit booms and low productivity growth:
  - Reis (2013), Gopinath et al. (2017), Doerr (2018), Garcia-Santana et al. (2020), Benigno et al. (2020), Caggese and Perez-Olive (2020), Gorton and Ordonez (2020), Asriyan et al. (2021).
- Zombie lending:
  - Caballero et al. (2006), Adalet-McGowan et al. (2018), Banerjee and Hofmann (2018), Tracey (2019), Schivardi et al. (2020).
- Heterogeneity and response to monetary policy shocks:
  - Cloyne et al. (2018), Jeenas (2019), Manea (2020), Anderson and Cesa-Bianchi (2020), Ottonello and Winberry (2020), Leahy and Thapar (2021).
- Negative side-effects of low and declining interest rates:
  - Rajan (2015), Dell'Ariccia and Marquez (2015), Martinez-Miera and Repullo (2017), Brunnermeier and Koby (2018), Liu et al. (2019), Bolton et al. (2021).
- Factor competition and financial frictions:
  - Ventura and Voth (2015), Martin et al. (2018), Asriyan et al. (2021).

The Model

Environment

- Two time periods: $t = 0, 1$.
- Two goods: consumption (c) and capital (k).
- All agents have preferences:

$$U^i = E_0\{C_1^i\},$$

where C_1^i is individual i's consumption at $t = 1$.

Environment

- Entrepreneurs (unit mass):
  - Endowed with $w > 0$ consumption goods at $t = 0$,
  - Can install k units of capital at $t = 0$ and receive $A \cdot k$ consumption goods at $t = 1$, where $A \sim^{\text{iid}} G$ with pdf g that has full support on $[0, 1]$.
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Environment

- Financial markets:
  - (For today) SOE: agents can borrow and lend at world interest rate R.
  - Friction: entrepreneur can walk away with a fraction $1 - \lambda$ of her output.
  - Endogenous borrowing limit:
$$R \cdot b \leq \lambda \cdot A \cdot k.$$
- Capital market:
  - Perfectly competitive, price q.
  - Capitalists supply capital; entrepreneurs purchase it.

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Equilibrium

- Capitalists' optimization implies weakly increasing capital supply $K^S(q)$.
- Entrepreneurs' optimization implies:

$$k_A(q;R)\begin{cases} = 0 & \text{if } \frac{A}{R} < q \\ \in \left[0, \frac{1}{q-\frac{\lambda A}{R}} \cdot w\right] & \text{if } q = \frac{A}{R} \\ = \frac{1}{q-\frac{\lambda A}{R}} \cdot w & \text{if } \frac{\lambda A}{R} < q < \frac{A}{R} \\ = \infty & \text{if } q \leq \frac{\lambda A}{R} \end{cases}.$$

- Capital market clearing: q is such that

$$K^S(q) = K = K^D(q;R) \equiv \int k_A(q;R) \cdot dG(A).$$

- Aggregate output of the economy at $t = 1$:

$$Y = \int A \cdot k_A(q;R) \cdot dG(A), \text{ where TFP} \equiv \frac{Y}{K}.$$

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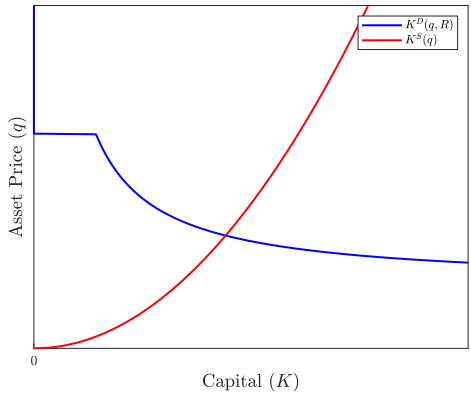
Benchmark: homogeneous productivity

All entrepreneurs have productivity A



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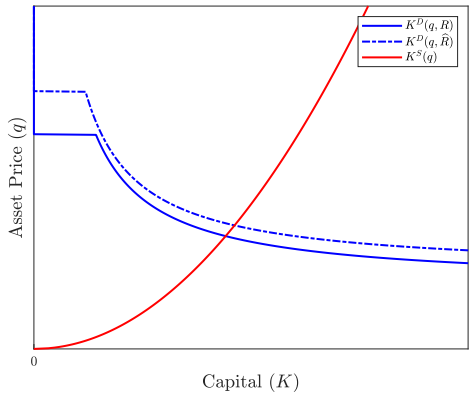
Effects of a fall in R



- Expansionary effect of a fall in R: K and Y increase (no change in TFP).

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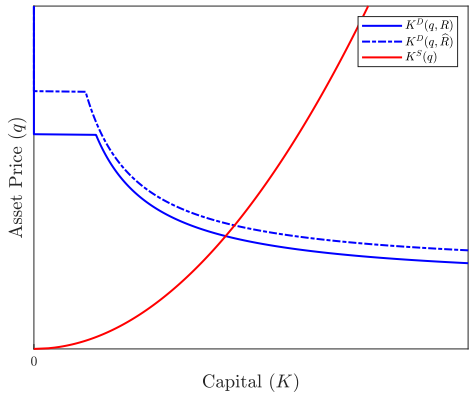

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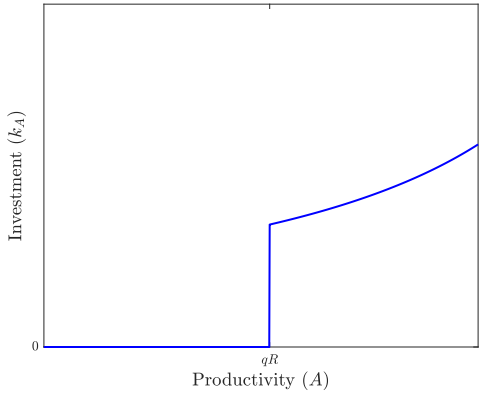
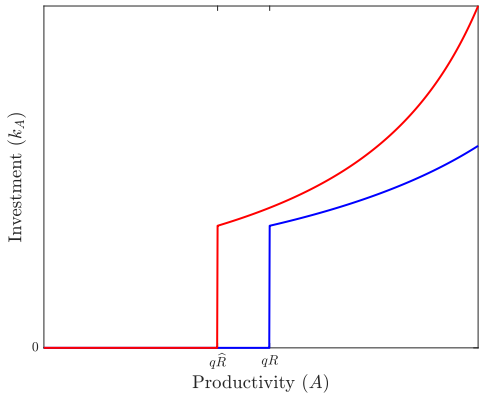
Heterogeneous productivity

- Now, we care about the distribution of k_A. Given $\{q, R\}$:



Heterogeneous productivity

- Given q, a fall in the interest rate:
  - generates investment by some infra-marginal entrepreneurs,
  - increases investment by supra-marginal entrepreneurs.



General-equilibrium effects

- Higher capital demand $\rightarrow$ q must rise to ensure market clearing.
- Hence, investment of *supra-marginal* entrepreneurs must change:

$$\frac{dk_A}{dR} = \frac{\left|\frac{dq}{dR}\right| - \frac{\lambda A}{R^2}}{q - \frac{\lambda A}{R}} \cdot k_A.$$

  - PE effect: a fall in R raises $\frac{\lambda A}{R}$ and reduces the required "down payment".
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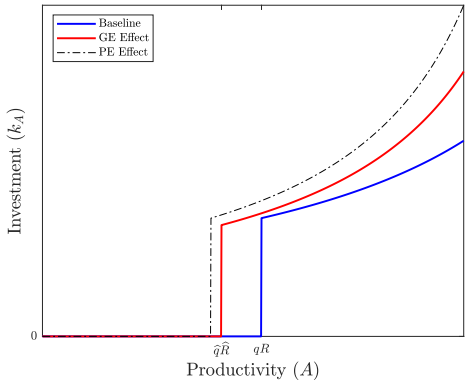
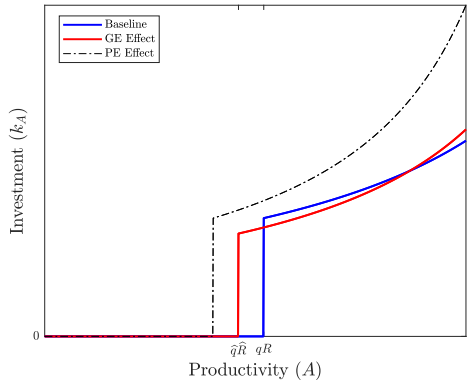


(a) Weak GE Effects



(b) Strong GE Effects

How does a fall in R affect Y?

- Effect of changes in R on aggregate output:

$$\frac{dY}{dR} = \underbrace{q \cdot R \cdot \frac{dK^S(q)}{dR}}_{\equiv \mathcal{K}} + \underbrace{\int_{q \cdot R}^{1} (A - q \cdot R) \cdot \frac{dk_A}{dR} \cdot dG(A)}_{\equiv \mathcal{R}}$$

- $\mathcal{K}$ captures a capital-supply effect:
  - always (weakly) negative;
  - a fall in R raises q and thus the aggregate stock of capital.
- $\mathcal{R}$ captures a capital-reallocation effect:
  - can be positive or negative, depending on strength of GE effects;
  - a fall in R raises q and redistributes K among entrepreneurs;
  - equals zero absent heterogeneous productivity or financial frictions.
- $\mathcal{R}$ is *strong* if it is more positive, whereas $\mathcal{K}$ is *strong* if it is more negative.

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Main result

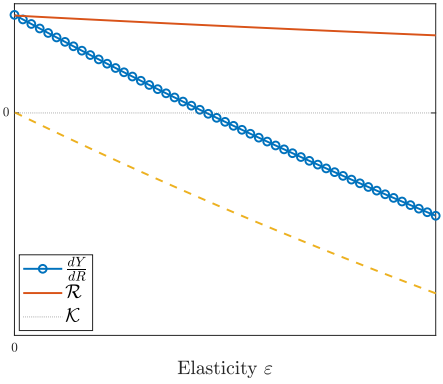
Proposition

Fix an equilibrium, and let ε denote the elasticity of capital supply with respect to the price of capital q at equilibrium. All else equal, as ε decreases:

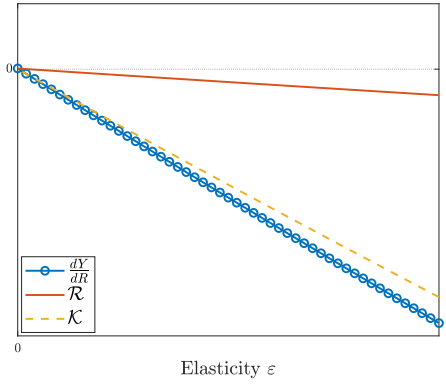
- *$\mathcal{K}$ gets weaker,*
- *$\mathcal{R}$ gets stronger,*
- *dY/dR increases.*

Moreover, for low enough ε, dY/dR becomes positive if λ is below a threshold.

Main result



(c) Low λ



(d) High λ

Normative properties

Constrained planning problem

- Consider a planner who dictates how much each entrepreneur invests:
  - subject to competitive markets, budget and financial constraints.
- The social planner maximizes aggregate consumption (welfare):

$$\max_{\{b_A, k_A\}} \int A \cdot k_A \cdot dG(A) - R \cdot (\chi(K^S(q)) - w)$$

subject to:

$$q \cdot k_A = w + b_A; \quad R \cdot b_A \leq \lambda \cdot A \cdot k_A; \quad K^S(q) = \chi^{-1}(q) = \int k_A \cdot dG(A).$$

- The planner's optimality condition for k_A:

$$A - q \cdot R - \chi''\left(K^S(q)\right) \cdot \int \gamma_{\bar{A}} \cdot \left| \frac{\partial}{\partial q} \left(\frac{1}{q - \frac{\lambda}{R} \bar{A}} \cdot w \right) \right| \cdot dG(\bar{A}) \lesseqgtr 0,$$

where $\gamma_A > 0$ if the financial constraint of entrepreneur with prod. A binds.

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Planner-optimal allocations

Let superscripts CE and SP denote the competitive equilibrium and the social planner's allocations, respectively.

Proposition

If $\widetilde{A}$ denotes the productivity of the marginal entrepreneur in the social planner's allocation, then:

$$\widetilde{A} > q^{CE} \cdot R > q^{SP} \cdot R.$$

Moreover, in the planner's allocation, a fall in R is always expansionary:

$$\frac{dY^{SP}}{dR} \leq 0,$$

with strict inequality if the capital supply is not perfectly inelastic.

Robustness and extensions

- Unconstrained firms, in addition to constrained entrepreneurs.
- Diminishing returns at entrepreneur level.
- Closed economy: fall in R is a result of a savings' glut.
- Dynamics of net worth accumulation + balance sheet effects.

Dynamics

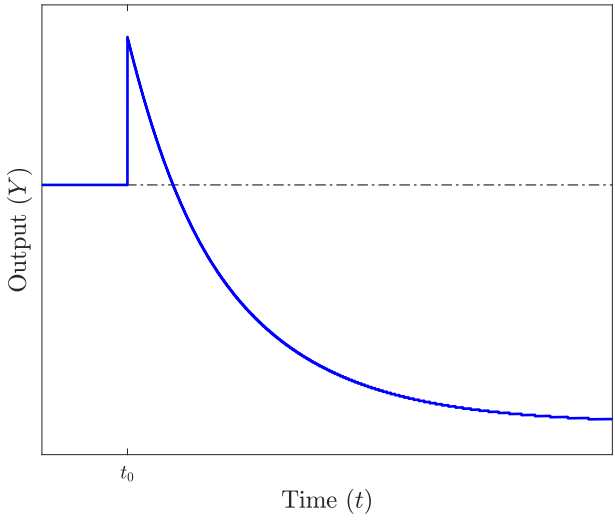
Dynamic setup

- Time is continuous, $t \geq 0$.
- Entrepreneurs: log-preferences with discount rate $\rho > r$,
  - allocate net worth w between capital $k \geq 0$ and risk-free debt b:
  $$q \cdot k - b = w.$$
  - produce:
  $$y = A \cdot k.$$
  - heterogeneous productivity A (exogenous) and wealth w (endogenous).
    - each instant fraction θ of entrepreneurs draws new productivity from G.
    - evolution of net worth:
    $$\dot{w} = y + \dot{q} \cdot k - r \cdot b - c.$$
- Capital stock is fixed at $\bar{K}$ in aggregate and traded at price q.
- Friction: entrepreneurs can walk away with fraction $1 - \lambda$ of capital,
$$b \leq \lambda \cdot q \cdot k.$$

Equilibrium

- Optimization:
  - consumption:
$$c = \rho \cdot w.$$
  - net worth evolves according to:
$$\dot{w} = (A + \dot{q} - r \cdot q) \cdot k + (r - \rho) \cdot w.$$
  - investment:
$$k = \begin{cases} \frac{1}{1-\lambda} \cdot \frac{w}{q} & \text{if } A + \dot{q} \geq r \cdot q \\ 0 & \text{otherwise} \end{cases}$$
- Market clearing:
$$\int_{A \geq q \cdot r - \dot{q}} \frac{1}{1-\lambda} \cdot \frac{W_A}{q} \cdot dA = \bar{K},$$
where $W_A = \int w \cdot f(A, w) \cdot dw$ and $f(A, w) \geq 0$ is the share of entrepreneurs with productivity A and net worth w.

Boom-bust dynamics of output



Empirical evidence (in progress)

- Main insight: a fall in the interest rate reallocates credit/investment towards relatively unproductive activities.
- Diff-in-diff analysis at sector-region level: when the interest rate falls...
  1. output expands less in regions with lower capital supply elasticity/sectors that are more capital intensive;
  2. productivity grows less be lower in regions with lower capital supply elasticity/sectors that are more capital intensive.
- Data from the US and Spain:
  1. real-world counterpart to capital supply:
     - interpret capital as real-estate,
     - use real-estate supply elasticity measures,
     - compute real-estate intensity using sectoral data.
  2. changes in interest rates:
     - alternative measures of interest rate changes (e.g. monetary policy shocks).

What have we learned?

- Stylized model with three key features:
  - entrepreneurs borrow to invest in capital,
  - heterogeneous productivity,
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