Interest Rate Liberalization and Capital Misallocation\textsuperscript{1}

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ABFER
May 22, 2018

\textsuperscript{1}The views expressed herein are those of the authors and do not necessarily reflect the views of the Federal Reserve Bank of San Francisco or the Federal Reserve System.
China’s interest rates have been tightly regulated.

Recent liberalization: lending rates (2013); deposit rates (2015).
Standard theory: Interest rate liberalization should improve capital allocation and productivity

- Financial frictions lead to misallocation and depressed productivity (e.g., Restuccia and Rogerson, 2008; Hsieh and Klenow, 2009; Buera, et al. 2011; Midrigan and Xu, 2014; Moll, 2014)
- Liberalization policy that alleviates financial frictions also improves allocation and productivity
  - Interest-rate liberalization raises deposit rate and lowers lending rate
  - Low-productivity firms choose to save instead of investing
  - Reallocation of capital improves aggregate productivity
With multiple distortions, consequences of interest-rate liberalization less clear

- China's SOEs have distorted incentives
  - SOEs face mandate of maintaining employment, not just maximizing profit (Bai, et al, 2006)
  - Government subsidizes SOEs to keep them operating despite low productivity: soft budget constraints (Lin, et al, 1998; Lin and Tan, 1999)
  - Gov't also gives SOE favorable access to credit (Brandt and Zhu, 2000)
- If private firms face tighter borrowing constraints than SOEs, interest-rate liberalization may exacerbate misallocation between SOEs and private firms
Studying full consequences of financial liberalization requires GE framework with multiple distortions

We build such a framework

- Two-sector model (SOE and POE), with heterogeneous firms and financial frictions
- Private firms (POE): profit-maximizing, facing borrowing constraints
- State firms (SOE): care about scale of production (soft budget constraints), less productive than POEs, but have easier access to credit
Interest-rate liberalization incurs tradeoff

- Improved allocation efficiency across firms within each sector (similar to one-sector model of Moll (2014))
- Exacerbated misallocation across sectors
- Overall effects on TFP and welfare ambiguous
- Tradeoff implies an interior optimum of interest-rate wedge
Quantitative results

• Calibrate model to Chinese data to study transition dynamics

• Liberalization: deposit rate rises and lending rate falls (the rates converge)

• Short-run recession caused by cross-sector misallocation: over-investment by SOEs

• Long-run expansion: increased aggregate saving and capital accumulation raise output

• During transition, cross-sector capital misallocation reduces TFP and output

• Complete liberalization leads to welfare loss of 2.9% consumption equivalent
A static model

- Two types of firms: state-owned enterprises (SOEs) with measure $\mu$ and private-owned enterprises (POEs) with measure $1 - \mu$; Each firm endowed with $h$ units of capital

- SOE firm uses 1 unit of capital to produces $z^s \varepsilon$ units output, with TFP $z^s$ and idiosyncratic productivity $\varepsilon \sim F(\varepsilon)$

- POE firm uses 1 unit of capital to produces $z^p \varepsilon$ units output, where TFP $z^p > z^s$

- Interest rate wedge: $r^l = r^d + \phi$
  - Base model: $\phi$ controlled by gov’t, $r^l$ and $r^d$ endogenous
  - Isomorphic setup: $r^d$ controlled by gov’t, $r^l$ and $\phi$ endogenous
POE’s problem

- POE firm with productivity $\varepsilon$ solves

$$\max_{\{k^P(\varepsilon), l^P(\varepsilon), s^P(\varepsilon)\}} z^P \varepsilon k^P (\varepsilon) - \left( r^d + \phi \right) l^P (\varepsilon) + r^d s^P (\varepsilon),$$

subject to flow-of-funds constraints

$$k^P (\varepsilon) = h + l^P (\varepsilon) - s^P (\varepsilon), \quad 0 \leq s^P (\varepsilon) \leq h.$$  

and borrowing constraint

$$l^P (\varepsilon) \leq \theta^P h$$
SOE’s problem

- SOE firm’s objective function

\[ \tau z^s \epsilon k^s(\epsilon) - \left( r^d + \phi \right) l^s(\epsilon) + r^d s^s(\epsilon), \]

- \( \tau > 1 \): distorted SOE incentive
  - Parsimony for soft budget constraints: gov’t subsidies, monopoly rents, or fixed costs
  - SOE’s private MPK exceeds social MPK \( \Rightarrow \) incentive to expand scale
- Flow-of-funds constraints

\[ k^s(\epsilon) = h + l^s(\epsilon) - s^s(\epsilon), \quad 0 \leq s^s(\epsilon) \leq h \]

- Borrowing constraint

\[ l^s(\epsilon) \leq \theta^s h \]

- SOEs have easier access to credit: \( \theta^p < \theta^s \)
Equilibrium

Given interest-rate controls ($\phi$), an equilibrium consists of the interest rate $r^d$ and allocations $\{k^j (\varepsilon), l^j (\varepsilon), s^j (\varepsilon)\}, j \in \{s, p\}$, such that

- Taking the interest rate as given, all firms solve their optimization problems
- Capital market clears

$$\mu \int k^s (\varepsilon) \, dF(\varepsilon) + (1 - \mu) \int k^p (\varepsilon) \, dF(\varepsilon) = h.$$ 

Aggregate output

$$Y = \mu \int z^s \varepsilon k^s (\varepsilon) \, dF(\varepsilon) + (1 - \mu) \int z^p \varepsilon k^p (\varepsilon) \, dF(\varepsilon).$$
Key frictions

• Interest rate wedge ($\phi$) captures existing interest rate regulations

• Borrowing constraints for all firms; SOEs have better access to credit ($\theta^p < \theta^s$)

• Policy wedge ($\tau > 1$): SOEs care about scale of production

• Second-best analysis: Would interest rate liberalization (reducing $\phi$) by itself improve aggregate productivity and welfare?
A simple example with homogeneous firms

- Assume $\tau z^s > z^p > z^s$ (SOEs’ private MPK exceeds their social MPK)
- Consider sufficiently large interest-rate wedge $\phi > \tau z^s - z^p$
- Consider equilibrium with $r^d = z^p$ so that POEs self-finance production ($k^p = h$)
- Since $r^l = z^p + \phi > \tau z^s$, SOEs also self-finance ($k^s = h$)
- This is an autarkic equilibrium with aggregate output

$$Y = [\mu z^s + (1 - \mu)z^p]h.$$
Interest rate liberalization with homogeneous firms

- Now remove the interest rate wedge: $\phi = 0 \Rightarrow r^l = r^d \equiv r$
- Interest rate
\[
r = \begin{cases} 
  z^p & \text{if } \theta^s < \frac{1}{\mu} - 1 \\
  \tau z^s & \text{if } \theta^s \geq \frac{1}{\mu} - 1
\end{cases}
\]
- If SOE borrowing capacity sufficiently large, then $r$ would be pinned down by SOE’s MPK
- Aggregate output
\[
Y^* = \begin{cases} 
  \mu z^s h(1 + \theta^s) + (1 - \mu) z^p h \left(1 - \frac{\mu}{1 - \mu} \theta^s\right) & \text{if } \theta^s < \frac{1}{\mu} - 1 \\
  z^s h & \text{if } \theta^s \geq \frac{1}{\mu} - 1
\end{cases}
\]
- Liberalization leads to capital flows from POEs to SOEs, reducing aggregate output ($Y^* < Y$)
The role of heterogeneity

• If firms are heterogeneous, interest rate liberalization improves resource allocation within each sector

• It can still cause misallocation across sectors

• Thus, there exists a trade-off → complete interest rate liberalization may not be desirable
Optimal capital allocations

• There exist two cutoff productivity levels $\bar{\epsilon}^j$ and $\bar{\epsilon}^j$ for each sector $j \in \{s, p\}$ such that

$$s^j(\epsilon) = \begin{cases} h & \text{if } \epsilon < \bar{\epsilon}^j \\ 0 & \text{if } \bar{\epsilon}^j \leq \epsilon \end{cases}$$

$$l^j(\epsilon) = \begin{cases} 0 & \text{if } \epsilon < \bar{\epsilon}^j \\ \theta^j h & \text{if } \bar{\epsilon}^j \leq \epsilon \end{cases}$$

$$k^j(\epsilon) = \begin{cases} 0 & \text{if } \epsilon < \bar{\epsilon}^j \\ h & \text{if } \bar{\epsilon}^j \leq \epsilon < \bar{\epsilon}^j \\ (1 + \theta^j) h & \text{if } \bar{\epsilon}^j \leq \epsilon \end{cases}$$

• The cutoff productivity levels are given by

$$\bar{\epsilon}^j = \frac{r}{z^j \tau^j}$$

$$\bar{\epsilon}^j_t = \frac{r + \phi}{z^j \tau^j}$$

where $\tau^s > \tau^p = 1$
Equilibrium

- Aggregate capital in sector $j \in \{s, p\}$

$$K^j = \left[ \int_{\epsilon_j}^{\bar{\epsilon}_j} dF(\epsilon) + (1 + \theta^j) \int_{\epsilon_j}^{\epsilon_{\text{max}}} dF(\epsilon) \right] h,$$

- Capital market clearing

$$K = \mu K^s + (1 - \mu) K^p = h.$$
Aggregate output and TFP

• Aggregate output $Y = \mu Y^s + (1 - \mu) Y^p$, where

$$Y^j = \left[ \int_{\tilde{\varepsilon}_j}^{\varepsilon_j} \varepsilon dF(\varepsilon) + (1 + \theta^j) \int_{\tilde{\varepsilon}_j}^{\infty} \varepsilon dF(\varepsilon) \right] z^j h, \quad j \in \{s, p\}$$

• Measured TFP at sector levels

$$A^j = \frac{Y^j}{K^j} = \frac{z^j}{\int_{\tilde{\varepsilon}_j}^{\infty} dF(\varepsilon) + (1 + \theta^j) \int_{\tilde{\varepsilon}_j}^{\infty} dF(\varepsilon)} \int_{\tilde{\varepsilon}_j}^{\varepsilon_j} \varepsilon dF(\varepsilon) + (1 + \theta^j) \int_{\tilde{\varepsilon}_j}^{\infty} \varepsilon dF(\varepsilon),$$

• Aggregate TFP

$$TFP = \frac{Y}{K} = A^s + (A^p - A^s)(1 - \mu) \frac{K^p}{h}$$
Macro effects of interest rate liberalization

- Liberalization (lower $\phi$) $\Rightarrow$ capital flows from POE to SOE
  
  $$\frac{\partial K^s}{\partial \phi} < 0, \quad \frac{\partial K^p}{\partial \phi} > 0.$$ 

- Liberalization raises POE TFP, but has ambiguous effect on SOE TFP
  
  - As deposit rate rises, low productivity firms in each sector become savers, raising sectoral TFP
  - But improvements within SOE sector partly offset by capital inflows

- Overall effects of liberalization on aggregate TFP ambiguous
Interest rate liberalization: a numerical example

• Consider effects of removing interest-rate wedge (set $\phi$ to 0)

• Parameters:

$$\frac{z^p}{z^s} = 2, \quad \theta^s = 0.75, \quad \theta^p = 0.25, \quad \tau = 3, \quad \mu = 0.5,$$

• Log-normal distribution of idiosyncratic productivity shocks
**Interior optimum of interest rate controls**

![Diagram showing the relationship between interest rate control and output with two curves for different values of \( \phi \).]

- Output 3  when \( \phi = 0.25 \)
- Output 3  when \( \phi = 0.5 \)
A dynamic model

- Firms operating in two sectors (SOE and POE) each faces an idiosyncratic productivity
- Firms in both sectors produce a final consumption good, using labor and capital as inputs
- Firms also accumulate capital
- A representative household owns firms, consumes the good, and supplies labor to firms
Firms

- Firms in sector $j$ face idiosyncratic productivity and borrowing constraints, with CRS production function

$$y_t^j = \left( z^j T_{t-1}^j \right)^{\alpha} \left( n_t^j \right)^{1-\alpha}$$

- A firm chooses labor input to maximize the profit

$$\pi_t^j \left( \varepsilon_{t-1}^j, k_t^j \right) = \max_{n_t^j} \left( z^j T_{t-1}^j \right)^{\alpha} \left( n_t^j \right)^{1-\alpha} - W_t n_t^j$$

- Maximum profit $\pi_t^j \left( \varepsilon_{t-1}^j, k_t^j \right) = \tau^j R_t z^j \varepsilon_{t-1}^j k_t^j$

- Stochastic exits: a fraction $\delta_e$ of firms exit in each period.
  - Pay out dividends upon exits
  - Equal mass of new firms enter, $h_{0t}^j$ startup funds
Firm’s decision problem

- Firm with productivity $\varepsilon^j_t$ chooses $k_{t+1}^j$, $l_{t+1}^j$, and $s_{t+1}^j$ to maximize the value function

$$V_t^j = \mathbb{E}_t \left[ \sum_{s=1}^{\infty} (1 - \delta_e)^s \beta^s \frac{\Lambda_{t+s}}{\Lambda_t} h_{t+s}^j \right]$$

- Net worth $h_t^j$ is given by

$$h_t^j = \left( \tau^j z^j \varepsilon_{t-1}^j R_t + 1 - \delta \right) k_t^j - (1 + r_{l,t-1}) l_t^j + (1 + r_{d,t-1}) s_t^j$$
Constraints for firm’s optimizing decisions

- Firm faces flow of funds constraint
  \[ h^j_t = k^j_{t+1} + s^j_{t+1} - l^j_{t+1}, \]
- and borrowing constraint
  \[ l^j_{t+1} \leq \theta^j h^j_t. \]
- Savings satisfy
  \[ 0 \leq s^j_{t+1} \leq h^j_t \]
The representative household

- The utility function
  \[ \sum_{t=0}^{\infty} \beta^t \log C_t, \]
  
- Budget constraint
  \[ C_t + \frac{B_t}{R_t} \leq W_t N_t + B_{t-1} + D_t - T_t \]
  
where \( B_t \) denotes risk-free bonds, \( R_t \) real interest rate, \( D_t \) dividends (net of startup funds), and \( T_t \) lump-sum taxes
Market clearing and equilibrium

- Loanable funds market clearing
  \[ \sum_{j \in \{s, p\}} L^j_{t+1} = \sum_{j \in \{s, p\}} S^j_{t+1}. \]

- Capital market clearing: \( K_{t+1} = \sum_{j \in \{s, p\}} H^j_t \)

- Labor market clearing: \( N^s_t + N^p_t = 1 \)

- Final goods market clearing
  \[ C_t + K_{t+1} - (1 - \delta) K_t = \sum_{j \in \{s, p\}} \left( \tilde{K}^j_t \right)^\alpha \left( N^j_t \right)^{1-\alpha} \]

- Bond market clearing: \( B_t = 0 \)
Calibration

• Fixed parameters: $\beta = 0.96$, $\delta = 0.1$, $\phi = 4\%$, $\alpha = 0.5$ (Zhu, 2012), $\delta_e = 0.06$ (Brandt, et al 2012)

• Idiosyncratic productivity $\varepsilon^j$: log normal, with mean normalized to one and standard deviation of $\sigma$

• Calibrate other parameters by targeting 5 moments
  1. SOEs share of output (40%); “SOE” $\approx$ government favored firms (such as heavy industry, see Chen, et al 2017)
  2. Real deposit interest rate (0.9%),
  3. Saving rate (0.41)
  4. Short-term loan to GDP (0.5)
  5. TFP of POE relative to SOE (1.6)
### Calibration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>SOEs</th>
<th>POEs</th>
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<tr>
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<td>$\alpha$</td>
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<td>$\delta_e$</td>
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<td>sector-specific TFP</td>
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<td>$h^j_0$</td>
<td>endowment of new firms</td>
<td>0.10</td>
<td>0.06</td>
</tr>
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</table>
Dynamic effects of liberalization

- Loan rate falls, deposit rate rises → more savings
- Capital flows from POE to SOE
- Short-run recession, long-run boom
Dynamic effects of liberalization on productivity

- Liberalization improves TFP within each sector...
- ...but worsens capital allocation across sectors
- In calibrated model, aggregate TFP falls

![Graphs showing TFP and SOE capital share](image-url)
Evidence for model’s reallocation mechanism

- Central implications of model: financial liberalization improves within-sector allocation, but worsens cross-sector allocation
- Direct evidence on reallocation effects of interest-rate liberalization not available (reforms happened only recently)
- But corroborating evidence exists
  - Gao, Ru, Townsend, Yang (2017): Bank entry deregulation of 2009 → new entrant banks mostly lent to SOEs (less productive but safe); increased competition between new and incumbent banks raised loan quality and borrowing firms’ efficiency
  - Chang, Liu, Spiegel, Zhang (2017): increases in required reserve ratio reduce SOE stock returns, loan shares, and investment shares → reallocating capital to productive POEs
  - Cong, Gao, Ponticelli, Yang (2018): loan-firm level data show that sharp credit expansion from fiscal stimulus reallocated capital to SOEs, despite their lower productivity
Welfare effects of liberalization

- Given policy wedge $\tau > 1$ and distorted credit access ($\theta^s > \theta^p$), interest-rate liberalization reduces welfare.
Counterfactual: reduced SOE subsidies

- Less SOE expansion $\Rightarrow$ liberalization raises TFP
Welfare effects of liberalization

- With less SOE subsidies, liberalization leads to smaller welfare losses and even welfare gains.
Counterfactual: improved POE credit access

- Consider equal access to credit by POEs and SOEs ($\theta^P = \theta^S$)
- Liberalization raises POE output and capital; improves TFP
Welfare effects of liberalization

- With improved POE credit access, interest-rate liberalization leads to welfare gains
Conclusion

- In a two-sector economy with multiple sources of frictions, complete interest-rate liberalization may not be desirable
  - Liberalizing interest-rate controls improves within-sector allocations and productivity
  - But it could exacerbate across-sector misallocation if SOEs care about production scale and have better access to credit
- Reform policy would be more effective if it addresses direct causes of distortions (SOE incentive, credit access)