

Interest Rate Liberalization and Capital Misallocation¹

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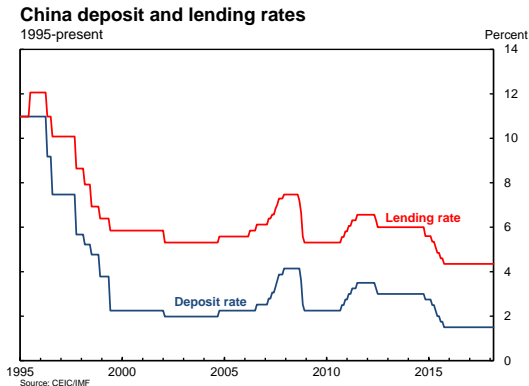
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China's interest rates have been tightly regulated



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 μ 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 produce $z^S \varepsilon$ units output, with TFP z^S and idiosyncratic productivity $\varepsilon \sim \mathbf{F}(\varepsilon)$
- POE firm uses 1 unit of capital to produce $z^P \varepsilon$ units output, where TFP $z^P > z^S$
- Interest rate wedge: $r^l = r^d + \phi$
 - Base model: ϕ controlled by gov't, r^l and r^d endogenous
 - Isomorphic setup: r^d controlled by gov't, r^l and ϕ endogenous

POE's problem

- POE firm with productivity ε solves

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

subject to flow-of-funds constraints

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

and borrowing constraint

$$I^P(\varepsilon) \leq \theta^P h$$

SOE's problem

- SOE firm's objective function

$$\tau z^s \varepsilon k^s(\varepsilon) - \left(r^d + \phi \right) I^s(\varepsilon) + r^d s^s(\varepsilon),$$

- $\tau > 1$: 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

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

- Borrowing constraint

$$I^s(\varepsilon) \leq \theta^s h$$

- SOEs have easier access to credit: $\theta^P < \theta^S$

Equilibrium

Given interest-rate controls (ϕ) , 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

$$\mu \int k^s(\varepsilon) d\mathbf{F}(\varepsilon) + (1 - \mu) \int k^p(\varepsilon) d\mathbf{F}(\varepsilon) = h.$$

Aggregate output

$$Y = \mu \int z^s \varepsilon k^s(\varepsilon) d\mathbf{F}(\varepsilon) + (1 - \mu) \int z^p \varepsilon k^p(\varepsilon) d\mathbf{F}(\varepsilon).$$

Key frictions

- Interest rate wedge (ϕ) 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 ϕ) 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 \rightarrow complete interest rate liberalization may not be desirable

Optimal capital allocations

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

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

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

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

- The cutoff productivity levels are given by

$$\underline{\varepsilon}^j = \frac{r}{z^j \tau^j}$$

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

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

Equilibrium

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

$$K^j = \left[\int_{\underline{\varepsilon}^j}^{\bar{\varepsilon}^j} d\mathbf{F}(\varepsilon) + (1 + \theta^j) \int_{\bar{\varepsilon}^j}^{\varepsilon_{\max}} d\mathbf{F}(\varepsilon) \right] h,$$

- 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

$$Y^j = \left[\int_{\underline{\varepsilon}^j}^{\bar{\varepsilon}^j} \varepsilon d\mathbf{F}(\varepsilon) + (1 + \theta^j) \int_{\bar{\varepsilon}^j}^{\infty} \varepsilon d\mathbf{F}(\varepsilon) \right] z^j h, \quad j \in \{s, p\}$$

- Measured TFP at sector levels

$$A^j = \frac{Y^j}{K^j} = z^j \frac{\int_{\underline{\varepsilon}^j}^{\bar{\varepsilon}^j} \varepsilon d\mathbf{F}(\varepsilon) + (1 + \theta^j) \int_{\bar{\varepsilon}^j}^{\infty} \varepsilon d\mathbf{F}(\varepsilon)}{\int_{\underline{\varepsilon}^j}^{\bar{\varepsilon}^j} d\mathbf{F}(\varepsilon) + (1 + \theta^j) \int_{\bar{\varepsilon}^j}^{\infty} d\mathbf{F}(\varepsilon)},$$

- 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 ϕ) \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

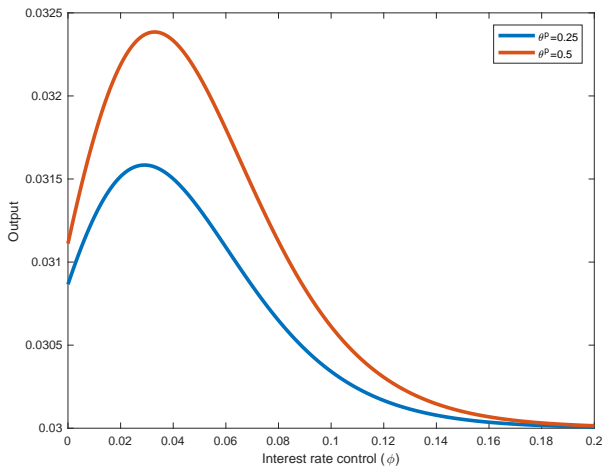
Interest rate liberalization: a numerical example

- Consider effects of removing interest-rate wedge (set ϕ 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



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

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

- A firm chooses labor input to maximize the profit

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

- 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 δ_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 ε_t^j chooses k_{t+1}^j , l_{t+1}^j , and s_{t+1}^j to maximize the value function

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

- Net worth h_t 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

$$h_t^j = k_{t+1}^j + s_{t+1}^j - l_{t+1}^j,$$

- and borrowing constraint

$$l_{t+1}^j \leq \theta^j h_t^j.$$

- Savings satisfy

$$0 \leq s_{t+1}^j \leq h_t^j$$

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

$$\sum_{j \in \{s,p\}} L_{t+1}^j = \sum_{j \in \{s,p\}} S_{t+1}^j.$$

- Capital market clearing: $K_{t+1} = \sum_{j \in \{s,p\}} H_t^j$
- Labor market clearing: $N_t^s + N_t^p = 1$
- Final goods market clearing

$$C_t + K_{t+1} - (1 - \delta) K_t = \sum_{j \in \{s,p\}} \left(\tilde{K}_t^j \right)^\alpha \left(N_t^j \right)^{1-\alpha}$$

- Bond market clearing: $B_t = 0$

Calibration

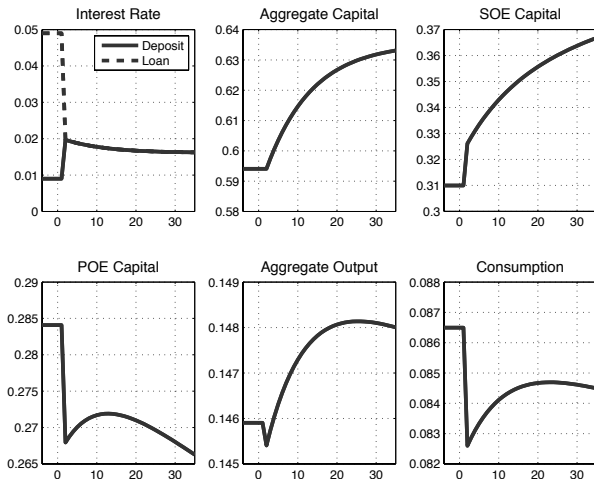
- Fixed parameters: $\beta = 0.96$, $\delta = 0.1$, $\phi = 4\%$, $\alpha = 0.5$ (Zhu, 2012), $\delta_e = 0.06$ (Brandt, et al 2012)
- Idiosyncratic productivity ε^j : log normal, with mean normalized to one and standard deviation of σ
- Calibrate other parameters by targeting 5 moments
 1. SOEs share 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

β	discounting factor	0.96	
α	capital share	0.5	
δ	capital depreciation rate	0.1	
δ_e	firm exit rate	0.06	
ϕ	interest rate gap	0.04	
		SOEs	POEs
θ^j	borrowing constraint	0.490	0.163
σ^j	standard deviation of ε^j	0.217	0.217
z^j	sector-specific TFP	0.021	0.055
τ^j	subsidies	2.56	1
h_0^j	endowment of new firms	0.10	0.06

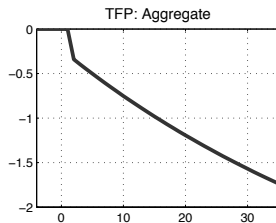
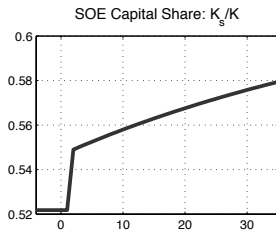
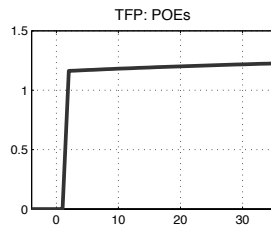
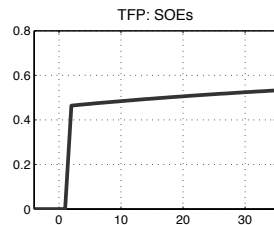
Dynamic effects of liberalization

- Loan rate falls, deposit rate rises \rightarrow 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

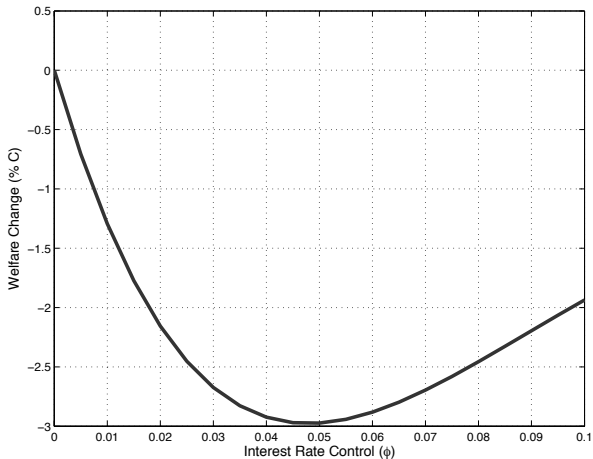


Evidence for model's reallocation mechanism

- 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

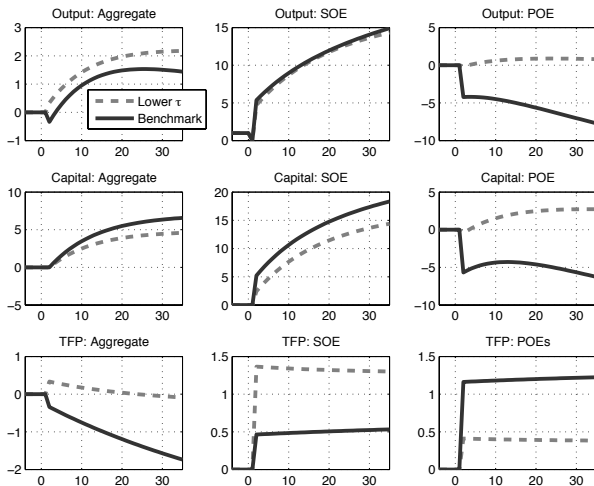
Welfare effects of liberalization

- Given policy wedge $\tau > 1$ and distorted credit access ($\theta^S > \theta^P$), interest-rate liberalization reduces welfare



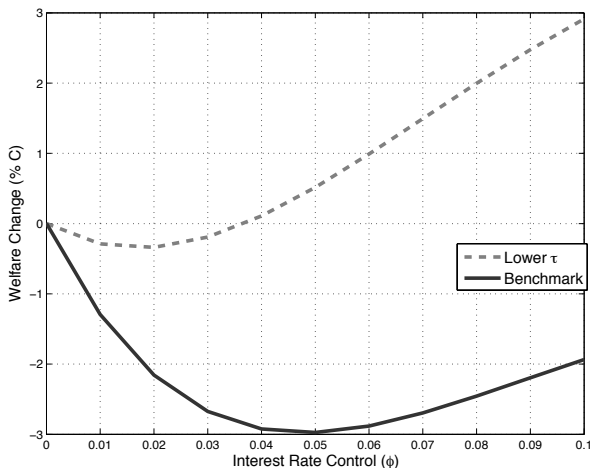
Counterfactual: reduced SOE subsidies

- Less SOE expansion \Rightarrow liberalization raises TFP



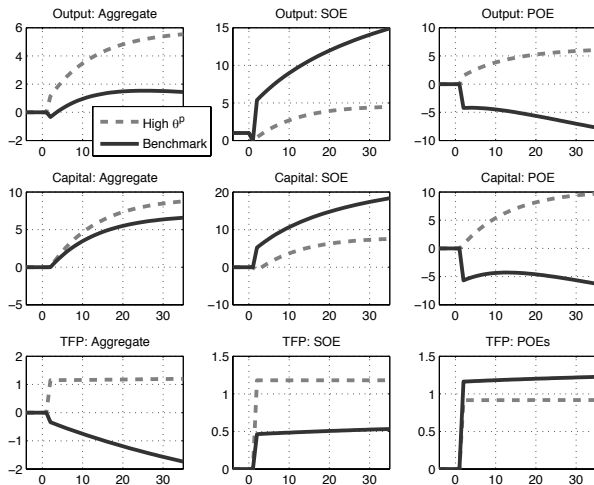
Welfare effects of liberalization

- With less SOE subsidies, liberalization leads to smaller welfare losses and even welfare gains



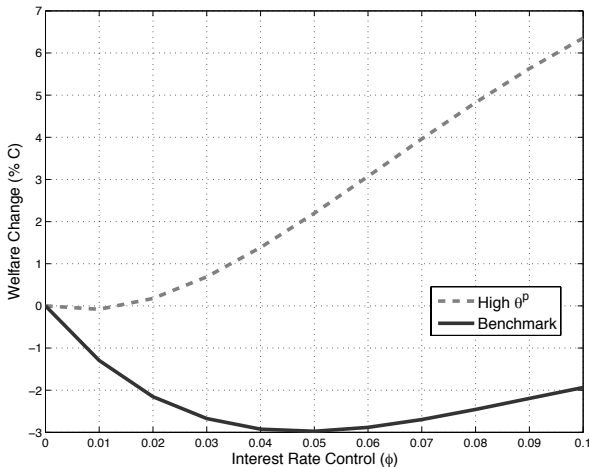
Counterfactual: improved POE credit access

- 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)