OPTIMAL CAPITAL ACCOUNT LIBERALIZATION IN CHINA

ZHENG LIU, MARK M. SPIEGEL, AND JINGYI ZHANG

Abstract. We examine the optimal pace of liberalizing China's capital account in a small open economy model with overlapping generations. The model features financial repression and capital account restrictions, similar to China's prevailing policy. Under financial repression, banks are required to lend a fraction of their funds to state-owned enterprises (SOEs) at below-market interest rates, whereas private firms can obtain fund only at the market interest rates. Capital account restrictions prohibit domestic citizens from participating in foreign asset markets. Under these policies, interest rates on domestic savings are lower than the world interest rate. Opening the capital account without first easing financial repression would lead to capital outflows, further raising the funding costs for productive private firms and exacerbating misallocation across sectors. In contrast, easing financial repression reallocates resources from SOEs to private firms, improving aggregate productivity. Our analysis suggests caution for liberalizing the capital account before easing domestic financial repression.

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Preliminary and incomplete. Please do not cite without permission. Liu: Federal Reserve Bank of San Francisco; Email: Zheng.Liu@sf.frb.org. Spiegel: Federal Reserve Bank of San Francisco; Email: Mark.Spiegel@sf.frb.org. Zhang: Shanghai Advanced Institute of Finance, Shanghai Jiao Tong University; Email: jyZhang.11@saif.sjtu.edu.cn. The views expressed in this paper 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.

I. Introduction

Financial repression and capital controls are the two primary sources of policy-induced distortions in the Chinese economy. Financial repression distorts credit extension, primarily in the form of requiring minimal levels of credit extension to state-owned enterprise (SOE) firms at favorable terms relative to those available to private firms (POEs).[1] China's capital control regime restricts the participation of domestic residents in international asset markets as well as that of foreign participation in Chinese asset markets, allowing for a wedge between domestic and international rates of return.

These capital account restrictions in China have been criticized as distortionary [e.g. Jeanne et al. (2012)].[2] It has also been argued that certain forms of capital account restrictions can be protectionist, effectively mimicking substantive tariff increases in practice (Wei and Zhang, 2007).

In a variety of policy announcements, China has signaled its intention to eventually liberalize both policies. However, the pace at which these policies should and will be liberalized is in question. Most expect these liberalizations are likely to move gradually, as it is commonly perceived that moving too quickly would disrupt real and financial activity in China.

The proper order of liberalization of these two distortions has been long studied. For example, Eichengreen et al. (2011) demonstrate that capital account liberalization can adversely impact countries with poorly-developed financial markets. Eichengreen and Leblang (2003) argue that, for a country with a distorted financial system that is conducive to excessive risk taking, opening the capital account may further increase leverage and thus raising the probability of a financial crisis. Similarly, Chinn and Ito (2006) argue that capital account liberalization can be detrimental in countries with insufficiently developed institutions. Ju and Wei (2010) show that capital account liberalization that would always improve welfare in advanced financial systems can have ambiguous effects under poorly-developed systems. Similarly, Aoki et al. (2009)

[1]In practice, large POE firms have little difficulty obtaining funds from China's commercial banks. But these firms typically do not rely on bank funding, and instead, they raise funds in bond and equity markets. This leaves SOEs the primary beneficiaries of China's financial repression.

[2]Chang et al. (2015) argue that capital account controls presented a challenge for China's central bank to stabilize domestic inflation, especially when the cost of sterilization increased during the global financial crisis period when advanced economies pursued unconventional monetary policy that resulted in low interest rates.

demonstrate that with poorly-developed financial systems capital account liberalization can potentially lead to long-run stagnation or short-run drops in employment, both of which can leave the liberalization policy welfare-reducing. Those who do advocate for capital account liberalization often rely on potential "secondary improvements," such as enhanced institutions stemming from exposure to foreign competition and standards [e.g. Kose et al. (2009)]. Given such ambivalence about potential policy outcomes from capital account liberalization in the literature, some have argued that domestic financial reform in China should move first before the country begins to liberalize its capital account [e.g. (Hsu, 2016)].[3]

In a recent survey of the literature, Wei (2018) notes that the logic of the argument that capital account liberalization may exacerbate resource misallocation under a distorted financial system in a developing country seems plausible, but "there is a lack of formal theories that articulate this link."

The goal of this paper is to fill this gap in the literature by building a theoretical model to evaluate the optimal pace of capital account liberalization under a distorted financial system. We develop a small open economy DSGE model with overlapping generations. The model features financial repression and capital controls, similar to the prevailing policy regime in China.

In the model, final consumption goods are produced using a composite of intermediate inputs from monopolistically-competitive SOEs and competitive POEs. Production technologies for these firms are identical except the POE firms have higher productivity than SOE firms. Both types of firms finance their working capital with bank loans.

Households live for two periods, working, consuming, and accumulating assets when young, and consuming their savings in retirement (old). Households save at a representative, competitive commercial bank. They can also purchase a foreign bond, but the earnings on foreign assets are taxed. This capital control tax drives a wedge between domestic deposit interest rate and the world interest rate.

Financial repression takes the form of a required quantity of credit (directed lending) to be extended at below-market terms to SOEs. SOEs are free to borrow beyond this minimal credit line at the market rates. POEs can borrow only at the market rates. Banks can remain solvent only if they compensate for their losses on directed lending to SOEs by paying a low interest rate on household deposits and charging a high

[3]See Wei (2018) for a nice survey of the literature.

interest rate on POE loans. This results in distortions both on savings rates and on the allocation of resources between the SOE and POE sectors.

We study a calibrated version of the model. We first explore the optimal financial repression and capital control policies that maximize social welfare in the steady state. We then explore the optimal policy reform order on financial repression and capital control with counterfactual analysis. In particular, we study the transitional dynamics – where either financial repression or capital control is liberalized faster than the other – and then evaluate the welfare gains under different policy reform regimes.

Our model illustrates a tradeoff between external and internal efficiency in opening the capital account. Relaxing controls on capital outflows improves the allocation between domestic investment and foreign investment, but under financial repression, it also shifts resources from the more productive POEs to the less productive SOEs. SOEs are less sensitive than POEs to the increase in the market lending rate that follows easing capital controls because SOEs continue to borrow a portion of their financing under the distorted directed lending rate. As a result, we find that under our calibration the optimal steady state level of capital controls is increasing in the magnitude of domestic financial repression.

However, because SOE output is sub-optimal due to monopolistic competition in that sector, we also find a non-zero level of financial repression is an optimal second-best steady state policy.

We next turn to optimal transition policy when, as in China, the share of output in the SOE sector is gradually declining.[4] We examine the welfare implications of alternative timing of liberalizations of financial repression and the capital account. Our analysis confirms that, under our calibration, immediate liberalization of financial repression is optimal. However, for any timing of financial repression liberalization, it is optimal to delay liberalizing the capital account until most of the transition in the share of SOE output has taken place.

Our model differs from other treatments of capital account liberalization in three dimensions: First, our consideration of a two-sector model is particularly (but not exclusively) attributable to the Chinese case, where capital account restrictions are motivated in part by the desire to maintain a minimal share of output in a favored, but less productive sector that would not emerge under free competition. Second, our use of an overlapping generations framework is conducive to modeling the implications of

[4]Chen et al. (2017) show that China's SOE share in total industry revenue has steadily declined from about 50% in 2000 to about 20% in 2016.

financial underdevelopment, as it disallows complete risk-sharing. Finally, our policy analysis considers the implications of gradual policy liberalization. In particular, we explicitly consider the implications of liberalizing the financial sector along with the capital account at a variety of relative paces. Our analysis therefore matches the gradualism that is likely to be a feature of capital account liberalization in China.

We are currently investigating the implications of opening the domestic asset market to foreign capital inflows within the DSGE framework. This work is still in progress. We conjecture that the analysis will also favor domestic financial liberalization before opening the capital account. As we show below, financial repression under a closed capital account pushes down domestic interest rates because banks need to compensate for losses on directed lending to remain solvent. It follows that financial repression of sufficient magnitude will push domestic deposit rates below the world interest rate. Under these conditions, if foreign capital inflows are allowed only through the banking sector (and domestic financial repression remains in place), prevailing deposit rates will be too low to attract any foreign inflows. If foreign capital was instead allowed to lend directly to the domestic private sector, then this would push down returns on the banks loans to the private sector and the banks would have to reduce domestic deposit rates further to remain solvent. This would be reduce household income. On the other hand, given that the private sector firms are more productive, the reallocation of activity towards that sector should act to improve aggregate productivity. A priori, it appears that the overall impact of of allowing foreign capital inflows on domestic welfare would be ambiguous. We therefore expect to find that financial repression and controls on capital inflows also are complementary, and liberalizing the form prior to the latter is likely desirable.

The remainder of this paper is divided into five sections: Section 2 introduces our model. Section 3 describes our calibration methodology. Section 4 reviews our quantitative results. Section 5 concludes.

II. The model

We consider a small open economy populated by households with overlapping generations. Each household lives for two periods—young and old. When young, the household works, consumes, and saves for retirement. When old, the household consumes the accumulated savings. The final consumption good is a composite of intermediate goods produced by firms in two sectors—one sector with state-owned enterprises (SOEs) and the other sector with private firms (POEs). Consistent with empirical evidence, SOEs have lower average productivity than POEs. Firms in both sectors rely on bank loans to finance wage payments and they face working capital constraints.

Banks operate in a perfectly competitive market, taking as given the interest rates on deposits and lending. Under financial repression, the government requires banks to lend a minimum share of their loans to SOEs at below-market interest rates. Banks can lend their remaining funds at market interest rates to SOEs, POEs, or foreign borrowers. Capital controls take the form of taxing earnings on foreign investment, and the foreign interest rate is taken as given.

II.1. **The households.** Each household lives for two periods, young in the first period and old in the second. Young households work for firms and receive labor income. They consume a part of their labor income and save the rest for retirement. Old households are retired and consume their accumulated savings.

A representative household born in period t has the utility function

$$\max_{C_t^y, C_{t+1}^o} \mathrm{E}\left\{ \ln(C_t^y) - \Psi_h \frac{H_t^{1+\eta}}{1+\eta} + \beta \ln(C_{t+1}^o) \right\}, \tag{1}$$

where C_t^y denotes consumption of the household when young, C_{t+1}^o denotes consumption when old, and H_t denotes hours worked when young.

The household chooses consumption, bank deposits, foreign investment, and capital investment to maximize the utility function (1) subject to the budget constraints

$$C_t^y + D_t + B_{ft} + q_t^k K_t^o + I_t + \frac{\Omega_k}{2}(\frac{I_t}{K_t^o} - \frac{\bar{I}}{\bar{K}_t^o})^2 K_t^o = w_t H_t + T_t + \Gamma_t, \tag{2}$$

$$C_{t+1}^o = R_t D_t + (1-\mu) R_t^* B_{ft} + d_{t+1} + [q_{t+1}^k (1-\delta) + r_{t+1}^k](K_t^o + I_t) - \Gamma_{t+1}. \tag{3}$$

When young, the household consumes C_t^y, makes bank deposit D_t and foreign investment B_{ft}, purchases existing capital from the then old generation (denoted by K_t^o) at the price q_t^k, and makes new investment I_t subject to the quadratic adjustment costs. In addition to receiving wage income $w_t H_t$ from firms, the young household also receives bequest income Γ_t from the previous old generation and a lump-sum transfer T_t from the government.[5]

When old, the household consumes the asset holdings, consisting of interest earnings on deposits $R_t D_t$, after-tax earnings on foreign investment $(1-\mu) R_t^* B_{ft}$, dividend

[5]Whether the lump-sum transfers are made to the young or the old does not affect the equilibrium outcome.

income d_{t+1} from firms that the household owns, and the returns from capital investment. The old household also leaves bequests B_{t+1} to the then-young generation. Here, the term R_t denotes the risk-free deposit rate, R_t^* denotes the world interest rate, r_{t+1}^k denotes the capital rental rate, and δ denotes the capital depreciation rate. The term μ is a tax on foreign investment earnings.

The optimizing conditions are summarized by the following equations:

$$\Lambda_t^y = \frac{1}{C_t^y}, \tag{4}$$

$$\Lambda_t^o = \frac{1}{C_t^o}, \tag{5}$$

$$w_t = \frac{\Psi H_t^\eta}{\Lambda_t^y}, \tag{6}$$

$$1 = \mathrm{E}_t \beta R_t \frac{\Lambda_{t+1}^o}{\Lambda_t^y}, \tag{7}$$

$$1 = \mathrm{E}_t \beta (1-\mu) R_t^* \frac{\Lambda_{t+1}^o}{\Lambda_t^y}, \tag{8}$$

$$q_t^k + \frac{\Omega_k}{2}(\frac{I_t}{K_t^o} - \frac{\bar{I}}{\bar{K}_t^o})^2 - \Omega_k(\frac{I_t}{K_t^o} - \frac{\bar{I}}{\bar{K}_t^o})\frac{I_t}{K_t^o} = \mathrm{E}_t \beta [q_{t+1}^k (1-\delta) + r_{t+1}^k] \frac{\Lambda_{t+1}^o}{\Lambda_t^y}, \tag{9}$$

$$1 + \Omega_k(\frac{I_t}{K_t^o} - \frac{\bar{I}}{\bar{K}_t^o}) = \mathrm{E}_t \beta [q_{t+1}^k (1-\delta) + r_{t+1}^k] \frac{\Lambda_{t+1}^o}{\Lambda_t^y},. \tag{10}$$

where Λ_t^y and Λ_t^o denotes the Lagrangian multiplier for the two budget constraints. Equations (7) and (8) imply the no-arbitrage condition that

$$R_t = (1-\mu) R_t^*. \tag{11}$$

A positive value of μ captures capital account controls. A higher value of μ implies more restrictive capital controls on outflows of domestic savings.

Denote by K_t the aggregate amount of physical capital available at the end of period t. Then,

$$K_t = K_t^o + I_t, \tag{12}$$

and

$$K_t^o = (1-\delta) K_{t-1}. \tag{13}$$

These relations imply the law of motion for the aggregate capital stock

$$K_t = (1-\delta) K_{t-1} + I_t. \tag{14}$$

II.2. **The final good sector.** Final goods producers are price takers. They use intermediate goods supplied by firms in the SOE sector and the POE sector as inputs to produce a final good. The production function is given by

$$Y_t = Y_{st}^{\phi_t} Y_{pt}^{1-\phi_t}, \tag{15}$$

where Y_t denotes the final good output, Y_{st} and Y_{pt} denote the intermediate input supplied by the SOEs and POEs, respectively, and the term $\phi_t \in (0,1)$ measures the share of intermediate input from the SOE sector.

Denote by p_{st} and p_{pt} the relative price of SOE products and POE products, respectively, both expressed in final consumption good units. Cost-minimizing by the final good producer implies that

$$Y_{st} p_{st} = \phi_t Y_t, \quad Y_{pt} p_{pt} = (1-\phi_t) Y_t. \tag{16}$$

The zero-profit condition in the final good sector implies that

$$1 = \left(\frac{\phi_t}{p_{st}}\right)^{\phi_t} \left(\frac{1-\phi_t}{p_{pt}}\right)^{1-\phi_t}. \tag{17}$$

II.3. **The intermediate good sectors.** Intermediate goods are produced in both the SOE sector and the POE sector. We focus on describing a representative firm in each sector $j \in \{s,p\}$, where s denotes SOE and p denotes POE.

A firm in sector j produces a homogeneous intermediate good Y_{jt} using capital K_{jt} and labor H_{jt} as inputs, with the production function

$$Y_{jt} = A_{jt}(K_{jt})^{1-\alpha}(H_{jt})^{\alpha}, \tag{18}$$

where A_{jt} denotes a sector-specific productivity facing all firms in sector j, and the parameter $\alpha \in (0,1)$ is the labor input elasticity in the production function.

Productivity A_{jt} contains a deterministic trend g^t that is common for both sectors and a stationary component A_{jt}^m that is specific to section j. In particular, we assume that $A_{jt} = g^t A_{jt}^m$. The stationary component A_{jt}^m follows the stochastic process

$$\ln A_{jt}^m = (1-\rho_j)\ln \bar{A}_j + \rho_j \ln A_{j,t-1}^m + \epsilon_{jt}, \tag{19}$$

where $\bar{A}_j$ is the steady-state level of A_j^m, $\rho_j \in (-1,1)$ is a persistence parameter, and the term ϵ_{jt} is an i.i.d. innovation and follows the log-normal distribution $N(0,\sigma_j)$.

Firms face working capital constraints. In particular, they need to pay a fraction θ of wage bills before production takes place. Firms finance their working capital payments through bank loans, B_{jt} at the interest rate R_{jt} and repay these loans after production by the end of the period. The working capital constraint for a firm in sector $j \in \{s, p\}$ is given by

$$B_{jt} = \theta(w_t H_{jt} + r_t^k K_{jt}). \tag{20}$$

We assume that firms in the SOE sector face perfectly competitive input markets but monopolistically competitive product markets, while firms in the POE sector face perfect competition in both input and product markets. Denote ϵ_j as the elasticity of substitution between products produced by different firms within the sector j. Our assumption of the market structure implies that the elasticity is finite for the SOE sector, but infinite for the POE sector.

Cost-minimizing by a firm in sector j implies the conditional factor demand functions

$$w_t H_{jt}(1 - \theta + R_{jt}\theta) = \alpha Y_{jt} p_{jt} \frac{\epsilon_j - 1}{\epsilon_j} \tag{21}$$

and

$$r_t^k K_{jt}(1 - \theta + R_{jt}\theta) = (1 - \alpha) Y_{jt} p_{jt} \frac{\epsilon_j - 1}{\epsilon_j}. \tag{22}$$

For SOE firms that face monopolistic competition, the term $\frac{\epsilon_s}{\epsilon_s - 1} > 1$ can be interpreted as a market. For POE firms that face perfect competition, the elasticity is infinity, and there is no markup pricing.

Both SOE firms and POE firms are owned by the household. Since the POE sector is perfectly competitive, the profit is zero. But SOE firms earn positive profits, which are paid out to the household in the form of dividends. The dividend payments are given by

$$d_{jt} = Y_{jt} p_{jt} - w_t H_{jt} - r_t^k K_{jt} + B_{jt} - R_{jt} B_{jt}. \tag{23}$$

Using the binding working capital constraints in Eq. (20) and the cost-minimizing conditions (21) and (22), it is straightforward to show that

$$d_{st} = \frac{1}{\epsilon_s} p_{st} Y_{st}, \quad d_{pt} = 0. \tag{24}$$

Thus, aggregate dividend payments received by the representative household is $d_t = d_{st}$.

II.4. **Banks.** There is a continuum of competitive banks in the model economy. The representative bank takes deposits from households and lends to firms in the two intermediate-good sectors. The bank pays households the deposit interest rate R_t. The bank can lend its loanable funds to SOEs or POEs. To capture financial repression in China, we assume that the government requires the bank to lend a minimum fraction of the funds to SOEs at a low interest rate. The bank lends the remaining funds to domestic firms at the market loan rate R_{pt}.

Denote by γ the share of directed lending to SOEs. We then have

$$B_{gt} \geq \gamma_t(B_{gt} + B_t). \tag{25}$$

A higher γ implies more severe financial repression. Here, B_t denotes the amount of loans that the bank can lend at the market interest rate R_{pt}.

For simplicity, assume that the net interest rate on directed lending is zero. The representative bank's profit maximization problem is given by,

$$B_{gt} + R_{pt}B_t - R_tD_t \tag{26}$$

subject to the financial repression constraint (25) and the flow of funds constraint

$$D_t \geq (B_{gt} + B_t) \tag{27}$$

The bank's optimizing decision implies that

$$R_t = \gamma + (1-\gamma)R_{pt}. \tag{28}$$

Under financial repression, the bank can break even only if it charges a loan interest rate R_{pt} that is higher than the deposit interest rate R_t. Financial repression thus drives a wedge between the loan rate and the deposit rate.

Furthermore, capital controls drive a wedge between the domestic deposit rate and the world interest rate (see Eq. (11)).

Note that the SOE loans have two components: directed lending B_{gt} with zero interest and normal lending $B_t - B_{pt}$ at the market interest rate R_{pt} (where B_{pt} is the amount loans that POEs receive). The average borrowing cost for SOEs is then given by

$$R_{st} = \frac{B_{gt} + R_{pt}(B_t - B_{pt})}{B_{gt} + (B_t - B_{pt})}. \tag{29}$$

II.5. **Market clearing.** We assume that foreign goods and domestic consumption goods are perfect substitutes. The trade surplus is given by,

$$NX_t = Y_t - C_t^y - C_t^o - I_t - \frac{\Omega_k}{2}(\frac{I_t}{K_t^o} - \frac{\bar{I}}{\bar{K_t^o}})^2 K_t^o. \tag{30}$$

The labor market and the capital market clears,

$$H_t = H_{st} + H_{pt}. \tag{31}$$

$$K_{t-1} = K_{st} + K_{pt}. \tag{32}$$

Summing up all sectors' budget constraints, we could obtain the balance of payments condition in our model,

$$NX_t + (R^*_{t-1} - 1)B_{f,t-1} = B_{ft} - B_{f,t-1} + \Delta_t. \tag{33}$$

Note that the last term $\Delta_t = (R_{st}B_{st} + R_{pt}B_{pt} - R_{s,t-1}B_{s,t-1} - R_{p,t-1}B_{p,t-1})$ emerges because of the time gap between domestic loan repayment (by the end of each period) and domestic deposit repayment (at the beginning of next period).

III. Calibration

We solve the model numerically based on calibrated parameters. The calibrated value of the parameters are summarized in Table 1.[6]

We set the subjective discount factor to $\beta = 0.665$, which implies an annualized discount rate of 0.96 if a period is 10 years. We set $\eta = 2$, implying a Frisch labor supply elasticity of 0.5, which lies in the range of empirical studies. We calibrate $\Psi_h = 38$ such that the steady state value of labor hour is about one-third of total time endowment (which itself is normalized to 1). For the parameters in the capital accumulation process, we calibrate $\delta = 0.651$, implying an annual depreciation rate of 10%. We set $\Omega_k = 1$, which lies in range of the empirical estimates of DSGE models. We set the foreign interest rate to $R^* = 1.629$, implying an annualized rate of 5%. We calibrate the steady-state value of Γ to 0.75, the transfer from old to young, which captures the practice of intergenerational exchange from parents to children in Chinese economy.[7]

For the parameters related to intermediate goods producers, we set the elasticity of substitution between differentiated products produced by SOE firms to $\epsilon = 20$, implying an average gross markup of 5%, which is consistent with the average spread in profit margins between SOEs and POEs. We normalize the scale of SOE TFP to $A_s = 1$ and calibrate the scale of POE TFP parameter to $A_p = 1.42$, consistent with the TFP gap estimated by Hsieh and Klenow (2009). We vary the share parameter ϕ of intermediate input produced by SOEs in our counterfactual policy analysis. In particular, we consider an initial steady state with $\phi = 0.5$, and set $\phi = 0.2$ at the new steady state state. These calibrated values of ϕ capture the observed steady declines in the share of SOE revenues in China's industrial output from 2000 to 2016, as documented by Chen et al. (2017).

[6] The numerical exercises are meant to be illustrative of the potential tradeoffs between alternative liberalization policies.

[7] We will recalibrate this parameter based on more direct empirical evidence.

Table 1. Calibration

Parameter	Description	Value
β	Household discount rate	0.665
η	Inverse of labor supply elasticity	2
Ψ_h	Utility weight of labor	38
δ	Capital depreciation rate	0.651
Ω_k	Capital adjustment cost	5
r^*	Foreign interest rate	1.629
τ	Transfer from old to young	0.75
θ	Fraction of working capital	1
ϵ	Elasticity of substitution among SOE firms	20
A_s	SOE TFP	1
A_p	POE TFP	1.42
ϕ	Share of SOE output	0.5
γ	Share of directed lending	0.5
μ	Tax rate on foreign investment	0.15

For the policy parameters, we set the share of directed lending $\gamma = 0.5$ in the initial steady state. According to China's Industrial Survey conducted by the National Bureau of Statistics, the share of SOE current liabilities in all industrial firms was about 60% in 2000. At that time, most of the bank lendings to SOEs were directed lending at subsidized interest rates, so a value of $\gamma = 0.5$ seems plausible.[8] We set the tax rate on foreign investment returns to $\mu = 0.15$, implying an annualized tax rate of 1.5% so that so that the model implies that $\frac{B_{ft}}{B_{ft}+D_t} = 0.1$, consistent with the average share of net foreign assets in total savings (sum of net foreign asssets and bank deposits) of about 10% during the period from 2004 to 2017 in China.

IV. Quantitative Results

IV.1. **Optimal steady-state capital control policy.** We begin by exploring how equilibrium allocations and welfare depend on the capital control policy. The model implies a tradeoff between external efficiency and internal efficiency as to relaxing capital control. In particular, relaxing capital control improves the allocation between domestic investment and foreign investment. However, in the presence of financial repression, relaxing capital control increases domestic lending rate and shifts resources from more productive POEs to less productive SOEs, as SOEs are less sensitive to the increase in market lending rate than POEs because the rate on directed lending is exogenous to changes in the market rate.

[8] Ideally, we should have more direct evidence on directed lendings to SOEs.

This tradeoff is illustrated in Figure 1, which displays the relations between the steady-state capital control policy (μ) and several macroeconomic variables. Relaxing capital control (μ decreases) increases domestic interest rate. In the presence of financial repression, POEs loan rate are more sensitive to domestic interest rate changes than SOE loan rate. Consequently, resources shifts from productive POEs to unproductive SOEs and the aggregate TFP falls. Meanwhile, reducing tax rate on foreign investment μ raises the foreign asset holdings and increase wealth gains from foreign investment. We can see that the representative household's setady-state welfare has a hump-shaped relation with μ and reaches its maximum at $\mu^* = 0.09$.

Figure 2 displays the optimal capital control policy under different degree of financial repression γ. When γ increases, the share of restricted lending increases and SOEs loan rate become even less sensitive to market rate changes. As a result, the TFP worsening effect of relaxing capital control policy becomes larger. Therefore, the optimal capital control becomes stricter and correspondingly the optimal tax on foreign investment increases.

IV.2. **Optimal steady-state financial repression policy.** We next explore how equilibrium allocations and welfare depend on the financial repression policy. In our model, the presence of monopolistic competition among SOEs discourage SOEs from producing at the desired level. Financial regression manipulates SOEs' funding cost to be lower than the market rate and therefore could help mitigate the distortion caused by monopolistic competition.

Figure 3 displays the relations between the steady-state financial repression policy (γ) and several macroeconomic variables. We can see that relaxing financial repression (γ decreases) leads to a shift from SOEs to POEs. Both the social welfare and the aggregate TFP is maximized when the share of SOE input equals its share in the aggregate production function. We can see that the monopolistic competition among SOEs makes it optimal to set γ positive.

Figure 4 displays the optimal financial repression policy under different degree of capital control μ. When μ increases, domestic deposit rate falls, which reallocate resources from SOEs to POEs. Therefore, the optimal share of directed lending increases to offset this reallocation effect.

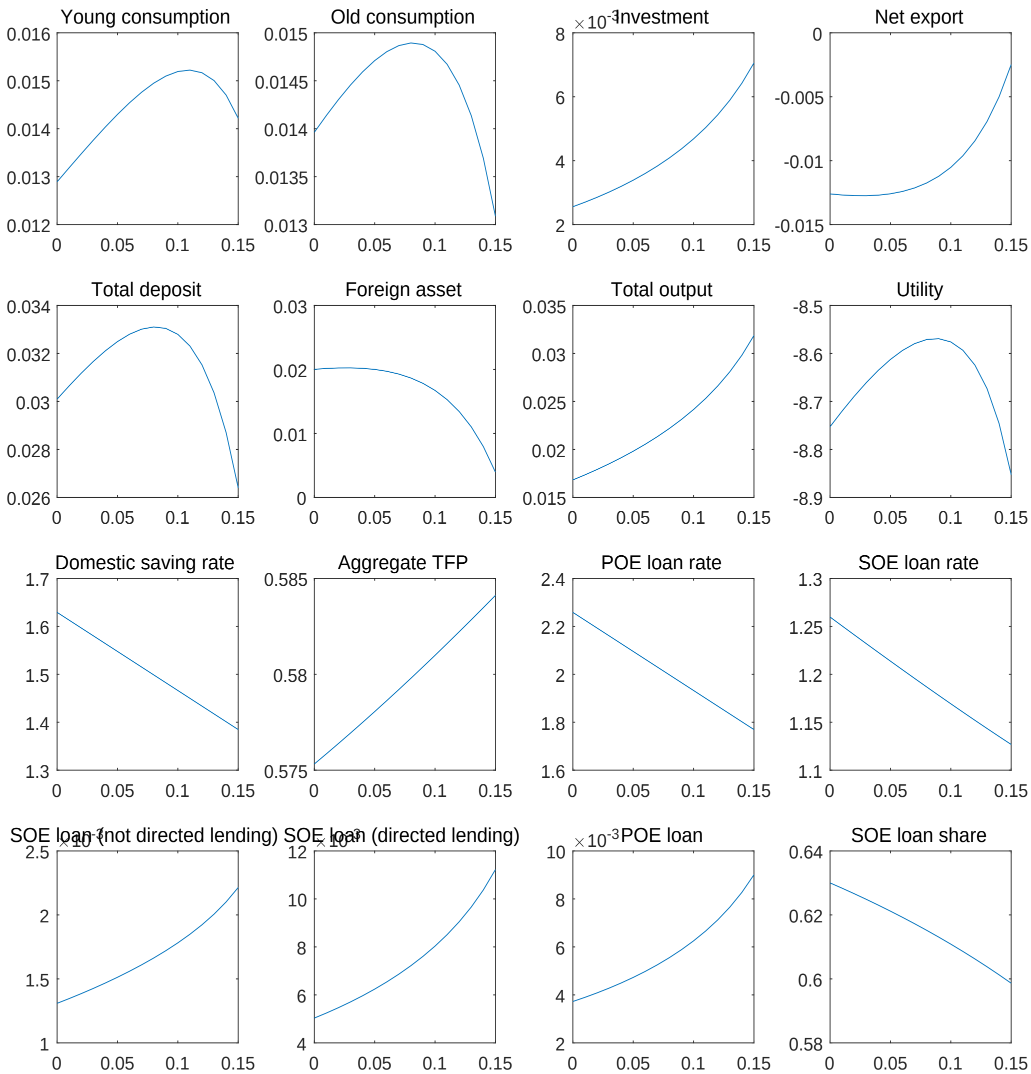


Figure 1. Steady-state implications of the capital control policy (μ) under baseline calibration. The x axis is the capital control parameter μ.

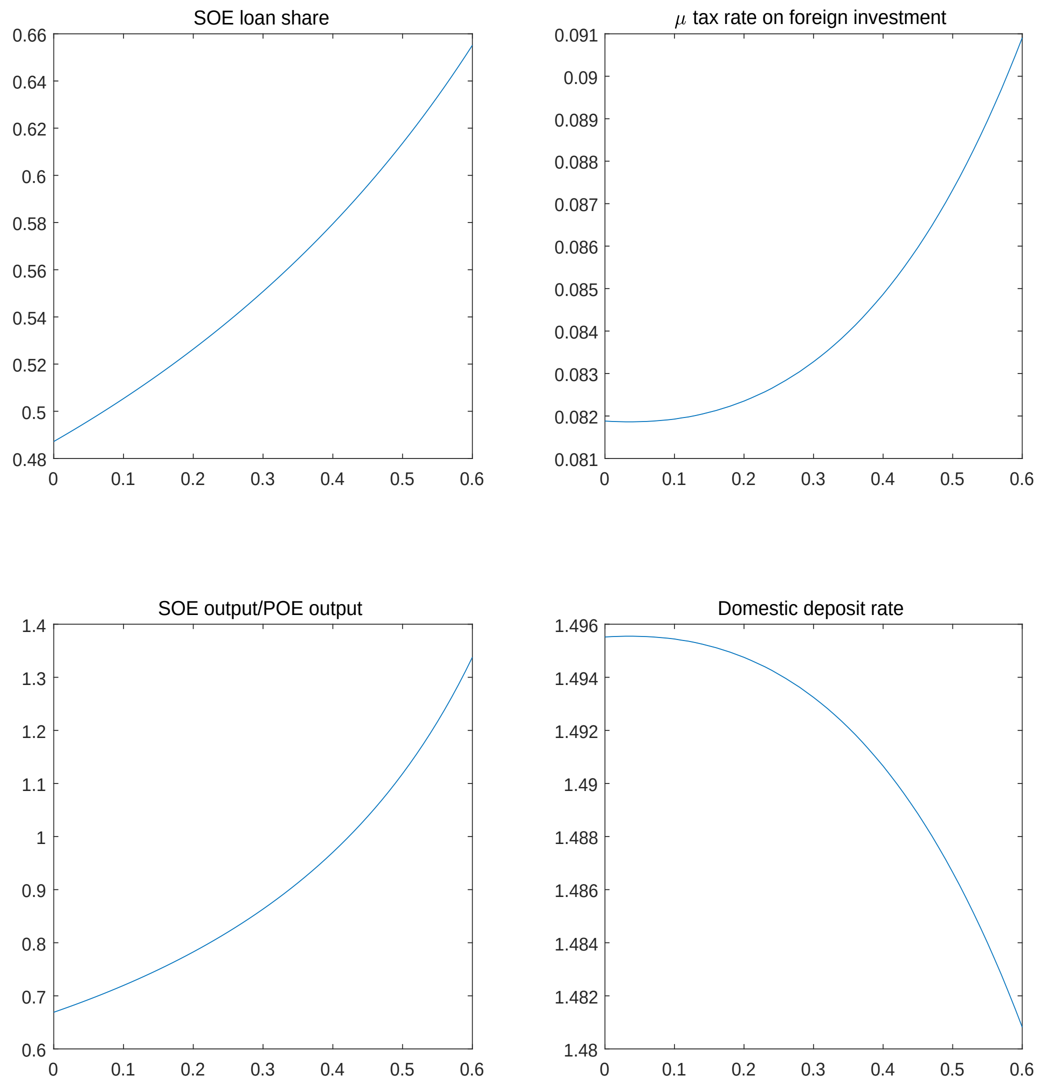


FIGURE 2. Optimal capital control policy under different degree of financial repression γ. The x axis is the financial repression parameter γ.

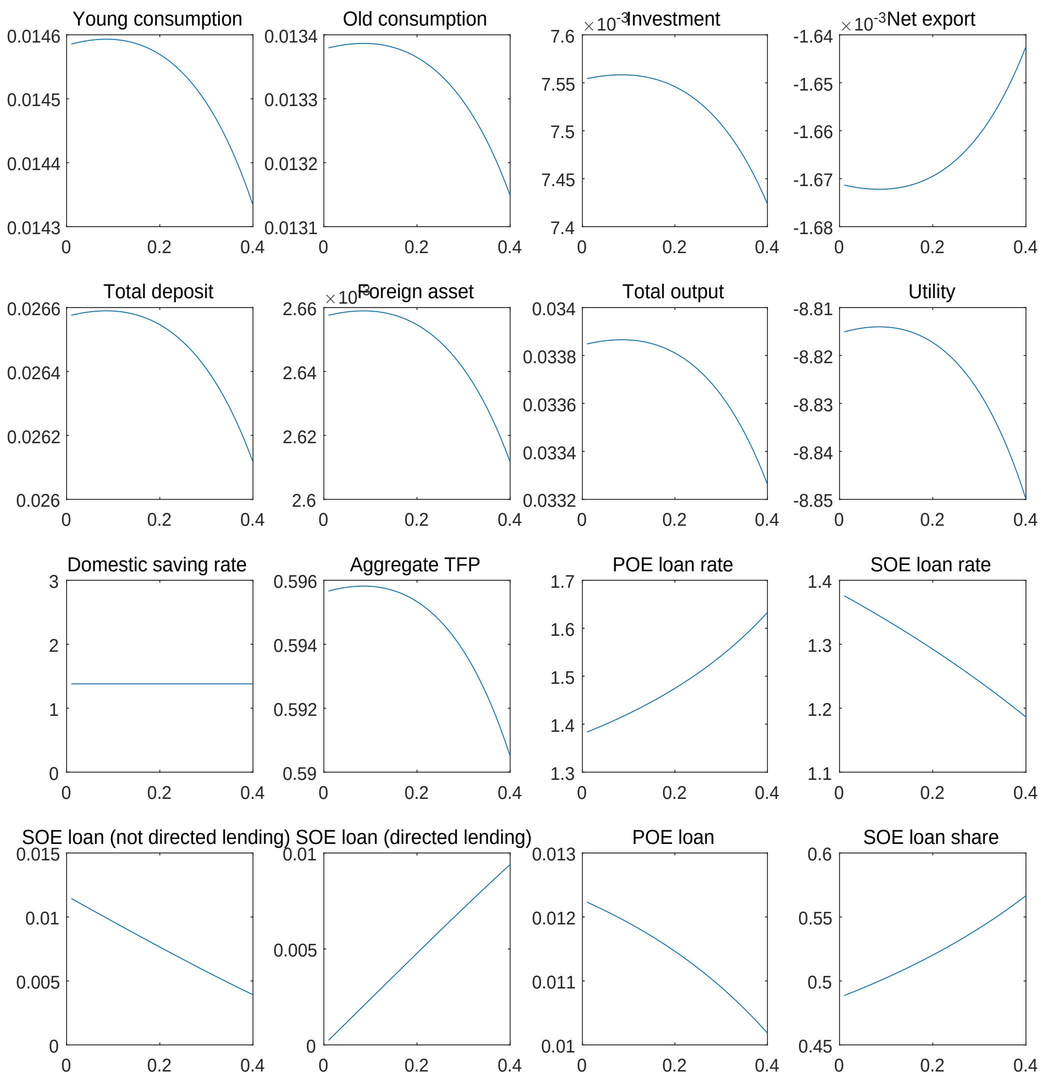


FIGURE 3. Steady-state implications of the financial repression policy (γ) under baseline calibration. The x axis is the financial repression parameter γ.

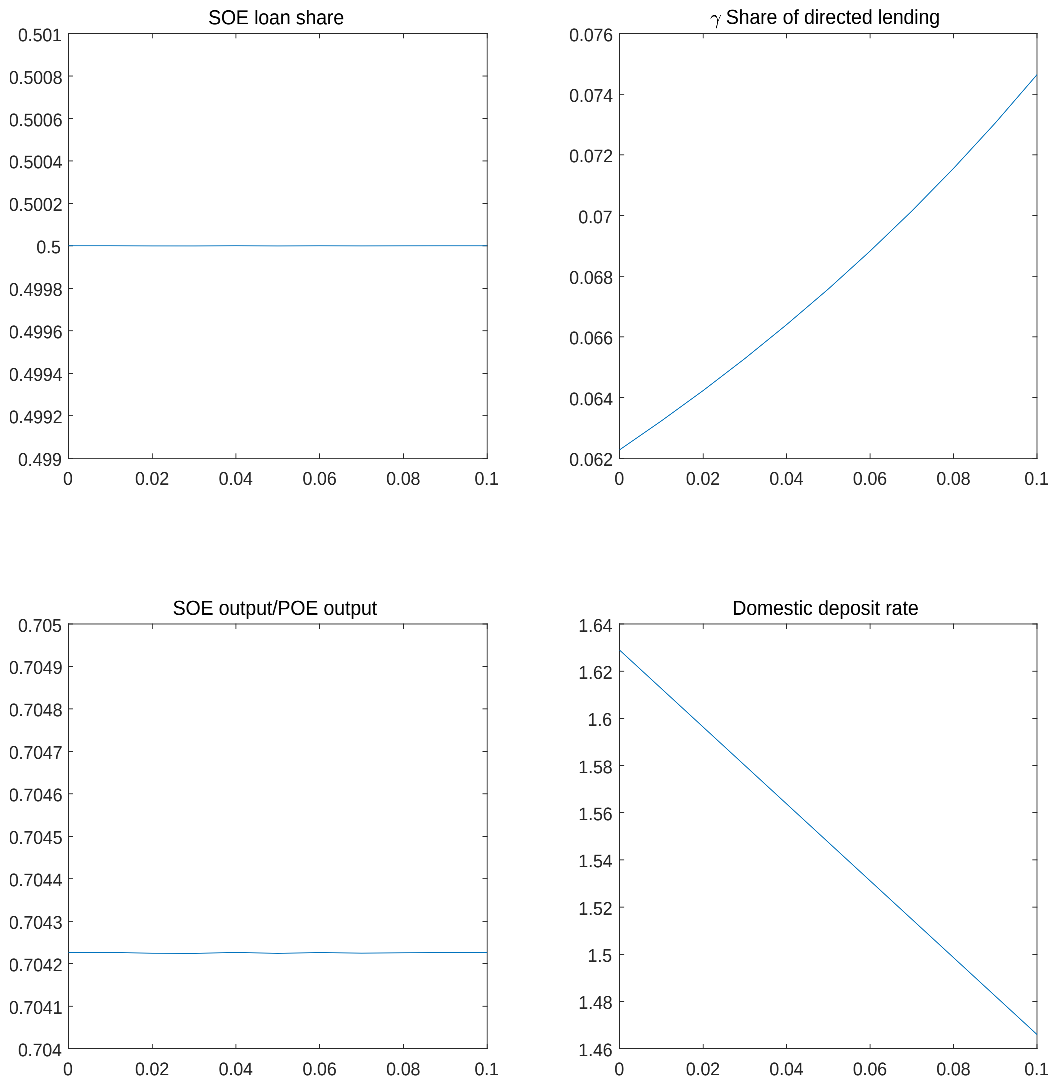


FIGURE 4. Optimal financial repression policy under different degree of capital control μ. The x axis is the capital control parameter μ.

IV.3. **Policy Exercise.** Chinese economy has experienced a persistent fall in the SOE sector relative to the POE sector over the last two decades. We first explores how this change will affect the optimal capital control policy and financial repression policy in the long run. Figure 5 displays the optimal capital control policy and financial repression policy that maximizes steady-state social welfare under various values of ϕ (the share of SOE input in the aggregate output function). We can see that when ϕ falls, it is optimal to reallocate resources from SOEs to POEs. Therefore, the optimal share of directed lending falls. Meanwhile, the fall in the share of directed lending makes the misallocation effect of lifting capital weaker. Therefore, the optimal tax rate on foreign interest rate falls.

We now consider a counterfactual experiment in which the share of SOE input ϕ falls in period $t = 1$. We examine the role of financial repression and capital control policy in the economy's transition to the new steady state.

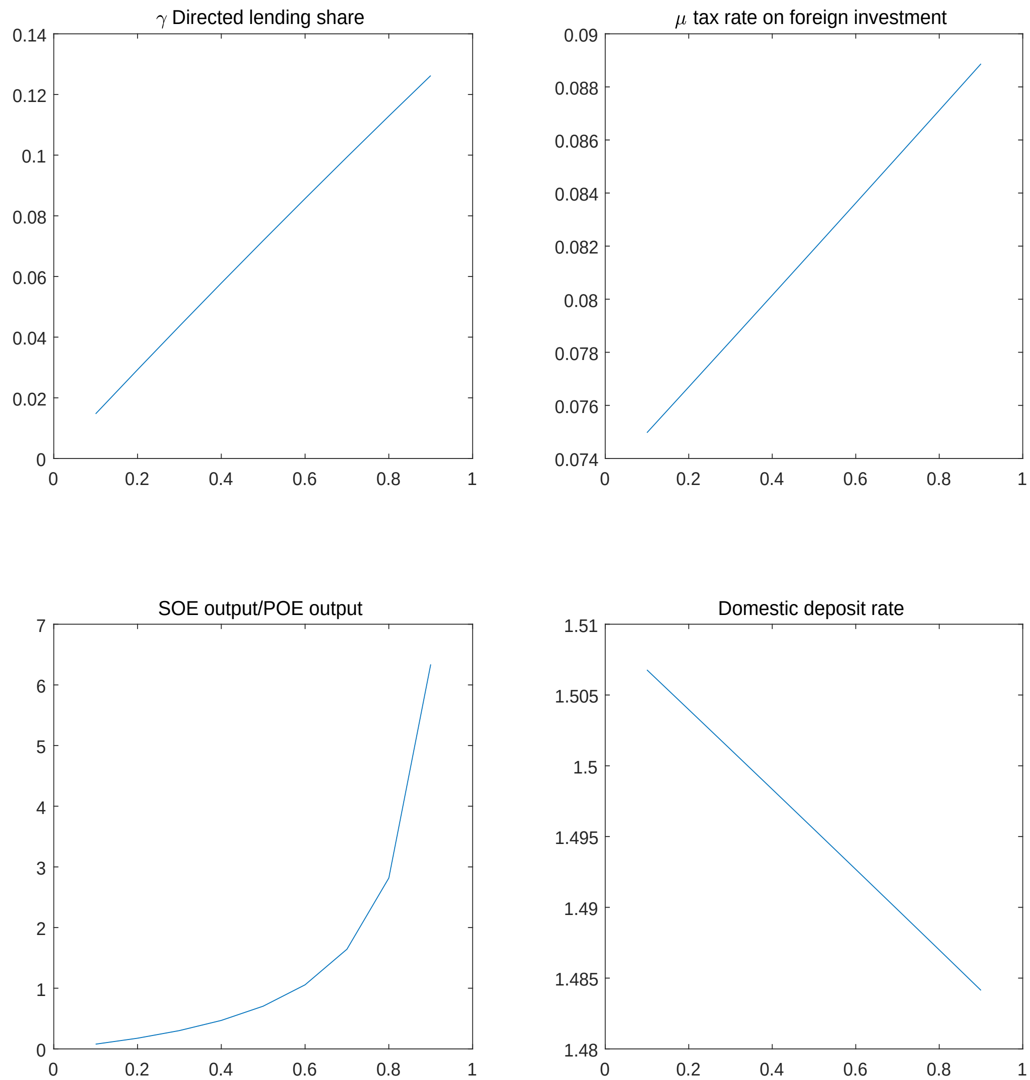
In particular, we consider the following structural changes. The economy starts in period $t = 0$ with the share of SOE input $\phi_0 = 0.5$ and the financial repression policy and the capital control policy are at their calibrated values of $\gamma_0 = 0.5$ and $\mu_0 = 0.15$. Note that both γ_0 and μ_0 are over their own optimal steady-state value, implying both financial repression and capital control are too tight at the initial steady state. Starting from period $t = 1$, the share of SOE input ϕ_t falls to $\phi_1 = 0.2$ and the government could choose to liberalize the financial repression or the capital control over the transition. In what follows, we consider two types of liberalization paths and investigate the long-studied question of the desirable "order of liberalization" for the Chinese case.

IV.4. **Complete liberalization at a certain period.** We assume that the government keeps γ_t unchanged at γ_0 before period $t = T_\gamma$ and liberalize financial repression to $\gamma_t = \gamma_1$ after period $t = T_\gamma$. Meanwhile, the government keeps μ_t unchanged at μ_0 before period $t = T_\mu$ and liberalize capital control to $\mu_t = \mu_1$ after period $t = T_\mu$. The transition path is then given by,

$$\begin{aligned} \phi_t : &\quad \phi_t = \phi_0 \quad if \quad t = 0, \phi_t = \phi_1 \quad if \quad t \geq 1, \\ \gamma_t : &\quad \gamma_t = \gamma_0 \quad if \quad t \leq T_\gamma - 1, \gamma_t = \gamma_1 \quad if \quad t \geq T_\gamma, \\ \mu_t : &\quad \mu_t = \mu_0 \quad if \quad t \leq T_\mu - 1, \mu_t = \mu_1 \quad if \quad t \geq T_\mu. \end{aligned}$$

where $\phi_0 = 0.5$, $\phi_1 = 0.2$, $\gamma_0 = 0.5$, $\mu_0 = 0.15$.

We then compute the welfare (the sum of the value functions for the old and the young) along the transition path, including the periods when the economy settles down



he share of SOE output in the aggregate output function.

FIGURE 5. Optimal capital control policy and financial repression policy under various SOE input shares ϕ. The x axis is the SOE input shares ϕ

in the new steady state. In particular, we define the welfare V_1 as the discounted sum of utility flow at t = 1 as follows,

$$V_1 = \sum_{t=1}^{\infty} \beta^t (\ln(C_t^y) - \Psi_h \frac{H_t^{1+\eta}}{1+\eta} \ln(C_t^o)), \tag{34}$$

We could express the welfare V_1 as a function of the degree of liberalization (μ_1, γ_1) and the timing of liberalization (T_μ, T_γ).

We first examine how the timing of liberalization affect the welfare along the transition path. In particular, we consider different pairs of (T_μ, T_γ), which corresponding to different timing of liberalization, and, for each pair, optimize the degree of liberalization for (μ_1, γ_1) to maximize the welfare evaluated along the transition path V_1. Figure 6 displays the numerial results.

The left panel displays the welfare evaluated along the transition path at optimal degree of liberalization under various pairs of liberalization timing. We can see that for any given timing of capital control liberalization T_μ, it is always optimal to liberalize financial repression immediately. This is reasonable as financial repression could help facilitate the transition by shifting resources from the SOE sector the POE sector.

However, it is not always optimal to liberalize capital control immediately. As the transition is driven by a fall in SOE output share and calls for resource reallocation from SOEs to POEs, liberalizing capital control immediately will raise domestic deposit rate and shift resources from POEs to SOEs, thus amplifying the distortion. Therefore, it is optimal to liberalize the capital control latter, after most of shift from SOEs to POEs has been implemented.

Note that financial repression plays an important role in driving the resource reallocation effect of capital control. In particular, it is because of the presence of directed lending such that SOEs become less sensitive to market interest rates than POEs and capital control liberalization could shift resources from POEs to SOEs by raising market interest rates. Indeed, the role of financial repression is shown in the figure: the latter the financial repression liberalization (higher T_γ), the latter the optimal period to liberalize capital control.

The middle panel displays the optimal degree of capital control after liberalization under various pairs of liberalization timing. We can see that the optimal degree of capital control after liberalization is lower if the time of capital control liberalization T_μ is higher. This suggests that, if the liberalization of capital control is postponed, then the degree of the liberalization should be more aggressive, which could help speed up the transition in the pre-liberalization period through the expectation channel.

The middle panel also suggests that, the optimal degree of capital control after liberalization is higher if the time of financial repression liberalization T_μ is higher. This is because, as previously discussed, postponing financial repression could undermine the welfare gains in liberalizing capital control and therefore makes the optimal capital control stricter.

The right panel displays the optimal degree of financial repression after liberalization under various pairs of liberalization timing. We can see that, the degree of financial repression should be more aggressive if either liberalization of captial control or liberalization of financial repression is postponed.

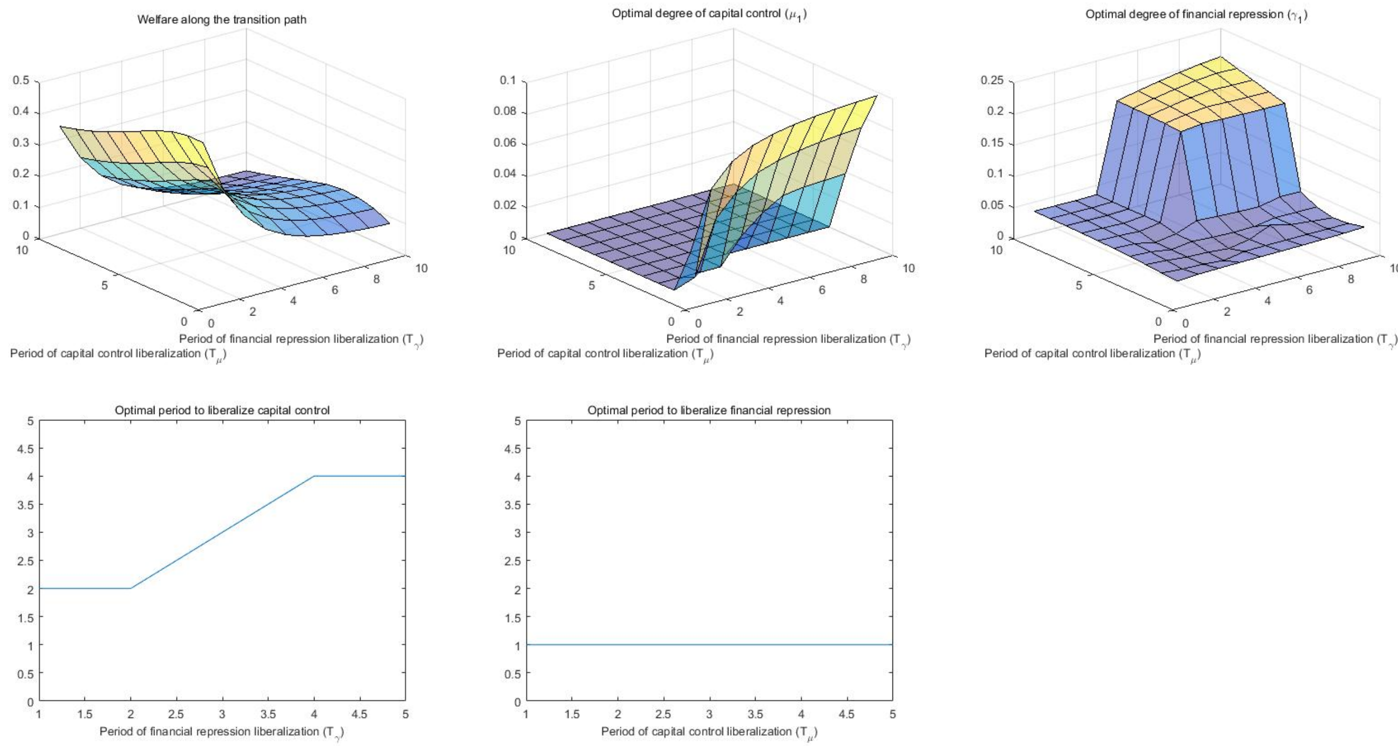


FIGURE 6. Welfare effect and optimal degree of liberalization under various pairs of liberalization timing. The transition path is as follows:

$$\phi_t: \quad \phi_t = \phi_0 \quad if \quad t = 0, \phi_t = \phi_1 \quad if \quad t \geq 1,$$

$$\gamma_t: \quad \gamma_t = \gamma_0 \quad if \quad t \leq T_\gamma - 1, \gamma_t = \gamma_1 \quad if \quad t \geq T_\gamma,$$

$$\mu_t: \quad \mu_t = \mu_0 \quad if \quad t \leq T_\mu - 1, \mu_t = \mu_1 \quad if \quad t \geq T_\mu.$$

where $\phi_0 = 0.5$, $\phi_1 = 0.2$, $\gamma_0 = 0.5$, $\mu_0 = 0.15$.

IV.5. **Gradual liberalization.** We assume that the government gradually liberalizes financial repression to $\gamma_t = \gamma_1$ at a speed captured by the parameter α_γ. Meanwhile, the government gradually liberalizes capital control to $\mu_t = \mu_1$ at a speed captured by the parameter α_μ. The transition path is given by,

$$\begin{aligned}
\phi_t: &\quad \phi_t = \phi_0 \quad if \quad t = 0, & \phi_t = \phi_1 \quad if \quad t \geq 1,\\
\gamma_t: &\quad \gamma_t = \gamma_0 \quad if \quad t = 0, & \gamma_t = \gamma 0 + (\gamma_1 - \gamma_0)[1 - (1 - \alpha_\gamma)^t] \quad if \quad t \geq 1,\\
\mu_t: &\quad \mu_t = \mu_0 \quad if \quad t = 0, & \mu_t = \mu 0 + (\mu_1 - \mu_0)[1 - (1 - \alpha_\mu)^t] \quad if \quad t \geq 1.
\end{aligned}$$

where $\phi_0 = 0.5$, $\phi_1 = 0.2$, $\gamma_0 = 0.5$, $\mu_0 = 0.15$.

We then compute the welfare (the sum of the value functions for the old and the young) along the transition path, including the periods when the economy settles down in the new steady state. In particular, we define the welfare V_1 as the discounted sum of utility flow at t = 1 as follows,

$$V_1 = \sum_{t=1}^{\infty} \beta^t (\ln(C_t^y) - \Psi_h \frac{H_t^{1+\eta}}{1+\eta} \ln(C_t^o)), \tag{35}$$

We could express the welfare V_1 as a function of the degree of liberalization (μ_1, γ_1) and the speed of liberalization $(\alpha_\mu, \alpha_\gamma)$.

We first examine the optimal liberalization path given the speed of financial repression liberalization. In particular, we consider different values of α_γ, which captures the speed of financial repression liberalization, and, optimize the other three parameters for $(\alpha_\mu, \mu_1, \gamma_1)$ to maximize the welfare evaluated along the transition path V_1. Figure 7 displays the numerial results.

We can see that, the optimal speed to liberalize capital control is lower if the liberalization of financial repression slows down. This result is consistent with the message delivered in the previous exercise: capital control should be liberalized after the liberalization of financial repression. We can also see that slowing down the liberalization of financial repression would undermine social welfare.

We then examine the optimal liberalization path given the speed of capital control liberalization. In particular, we consider different values of α_μ, which captures the speed of financial repression liberalization, and, optimize the other three parameters for $(\alpha_\gamma, \mu_1, \gamma_1)$ to maximize the welfare evaluated along the transition path V_1. Figure 8 displays the numerial results.

We can see that, it is always optimal to liberalize financial repression immediately whatever the speed of capital control liberalization. We can also see that speeding up the liberalization of capital control requires the government to increase the magnitude of financial repression liberalization. This is because capital control liberalization could hinder the transition of moving from the SOE sector to the POE sector by raising market interest rates and shifting resources from POEs to SOEs by raising market interest rates. Consequently, the government has to reduce financial repression to a larger extent to offset this allocation effect.

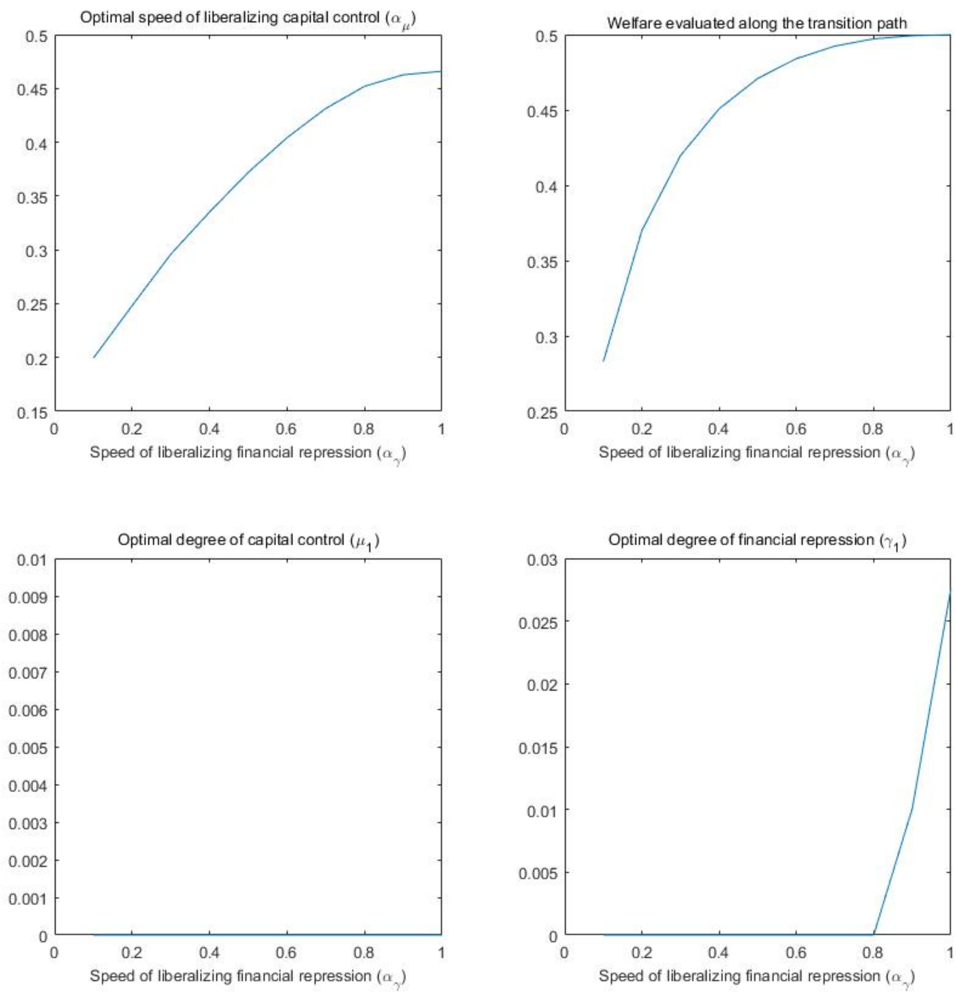


FIGURE 7. Welfare effect and optimal degree of liberalization as the speed of financial repression liberalization varies.

The transition path is as follows:

$$\phi_t: \quad \phi_t = \phi_0 \quad if \quad t = 0, \qquad \phi_t = \phi_1 \quad if \quad t \geq 1,$$

$$\gamma_t: \quad \gamma_t = \gamma_0 \quad if \quad t = 0, \qquad \gamma_t = \gamma 0 + (\gamma_1 - \gamma_0)[1 - (1 - \alpha_\gamma)^t] \quad if \quad t \geq 1,$$

$$\mu_t: \quad \mu_t = \mu_0 \quad if \quad t = 0, \qquad \mu_t = \mu 0 + (\mu_1 - \mu_0)[1 - (1 - \alpha_\mu)^t] \quad if \quad t \geq 1.$$

where $\phi_0 = 0.5$, $\phi_1 = 0.2$, $\gamma_0 = 0.5$, $\mu_0 = 0.15$.

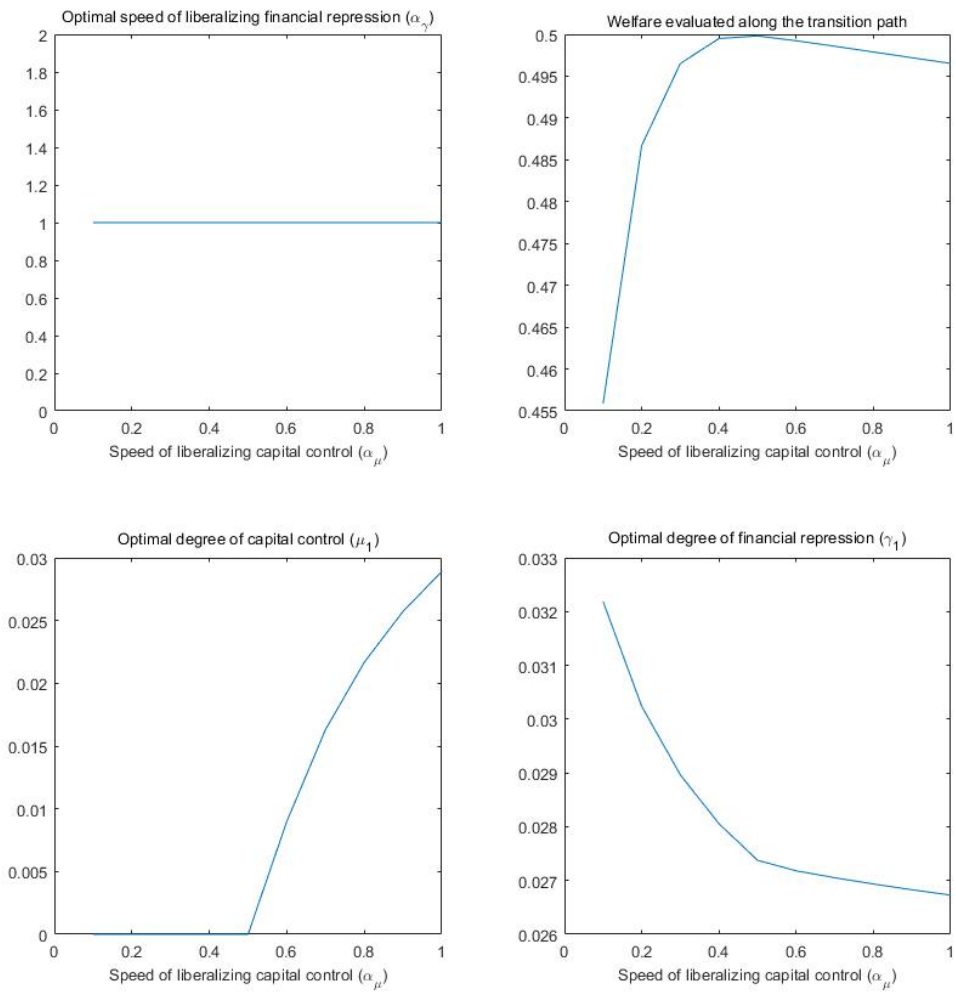


FIGURE 8. Welfare effect and optimal degree of liberalization as the speed of capital control liberalization varies.

The transition path is as follows:

$$\phi_t: \quad \phi_t = \phi_0 \quad if \quad t = 0, \qquad \phi_t = \phi_1 \quad if \quad t \geq 1,$$

$$\gamma_t: \quad \gamma_t = \gamma_0 \quad if \quad t = 0, \qquad \gamma_t = \gamma 0 + (\gamma_1 - \gamma_0)[1 - (1 - \alpha_\gamma)^t] \quad if \quad t \geq 1,$$

$$\mu_t: \quad \mu_t = \mu_0 \quad if \quad t = 0, \qquad \mu_t = \mu 0 + (\mu_1 - \mu_0)[1 - (1 - \alpha_\mu)^t] \quad if \quad t \geq 1.$$

where $\phi_0 = 0.5$, $\phi_1 = 0.2$, $\gamma_0 = 0.5$, $\mu_0 = 0.15$.

V. CONCLUSION

TO BE DONE.

References

Aoki, K., G. Benigno, and N. Kiyotaki (2009, June). Adjusting to capital account liberalization. Mimeo, London School of Economics and Princeton University.

Chang, C., Z. Liu, and M. M. Spiegel (2015). Capital controls and optimal chinese monetary policy. *Journal of Monetary Economics 74*, 1–15.

Chen, K., P. Higgins, D. F. Waggoner, and T. Zha (2017, September). Impacts of monetary stimulus on credit allocation and macroeconomy: Evidence from china. NBER Working Paper No. 22650.

Chinn, M. and H. Ito (2006). What matters for financial development? *Journal of Development Economics 81*, 163–192.

Eichengreen, B., R. Gullapalli, and U. Panizza (2011). Capital account liberalization, financial development and industry growth: A synthetic view. *Journal of International Money and Finance 30*, 1090–1106.

Eichengreen, B. and D. Leblang (2003). Capital account liberalization and growth: Was mr. mahathir right? *The International Journal of Finance and Economics 8*(3), 205–224.

Hsu, S. (2016). China's banking sector as the foundation of financial reform. *Asia and the Pacific Policy Studies 3*(2), 244–248.

Jeanne, O., A. Subramanian, and J. Williamson (2012). *Who needs to open the capital account?* Washington, D.C.: Peterson Institute for International Economics.

Ju, J. and S.-J. Wei (2010). Domestic institutions and the bypass effect of financial globalization. *American Economic Journal: Policy 2*(4), 173–204.

Kose, A., E. Prasad, K. Rogoff, and S.-J. Wei (2009). Financial globalization: A reappraisal. *International Monetary Fund Economic Review 56*(1), 8–62.

Wei, S.-J. (2018, February). Managing financial globalization: Insights from the recent literature. NBER Working Paper No. 24330.

Wei, S.-J. and Z. Zhang (2007). Collateral Damage: Capital Controls and International Trade. *Journal of International Money and Finance 26*(5), 841–863.