

OPTIMAL CAPITAL ACCOUNT LIBERALIZATION IN CHINA

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ABSTRACT. China maintains tight controls over its capital account. Its current policy regime also features financial repression, under which banks are required to extend funds to state-owned enterprises (SOEs) at favorable terms, despite their lower productivity than private firms. We incorporate these features into a general equilibrium model. We find that capital account liberalization under financial repression incurs a tradeoff between aggregate productivity and inter-temporal allocative efficiency. Along a transition path with a declining SOE share, welfare-maximizing policy calls for rapid removal of financial repression, but gradual liberalization of the capital account.

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I. INTRODUCTION

China has maintained a policy regime with tight controls over its capital account. Under this regime, domestic citizens are restricted from investing abroad and foreign investors are restricted from accessing China's financial markets. In recent years, the Chinese government has signaled its intention to liberalize its capital account, although the pace of liberalization remains uncertain. Some authors advocate gradual liberalization, arguing that rapid removal of capital account restrictions might disrupt domestic economic activity, particularly given China's distorted financial system. Such a country should thus liberalize its capital account gradually.¹

China's financial distortions primarily take the form of financial repression, under which banks are encouraged to favor state-owned enterprises (SOEs) and other heavy-industry firms in their lending decisions, despite the fact that SOEs are on average less productive than private firms.² In contrast, private firms have access to credit only at higher market interest rates. Given these distortions, it is possible that capital account liberalization may exacerbate resource misallocation. However, as discussed in Wei (2018), "there is a lack of formal theories that articulate this link."

In this paper, we present a theoretical model to evaluate the general equilibrium effects of optimal capital account liberalization policy under China's distorted financial system. We build a small open economy model with overlapping generations, featuring financial repression and capital controls, similar to the prevailing policy regime in China. Households live for two periods—young and old. When they are young, they work, consume, and accumulate assets; when they are old, they retire and consume savings. To save, a young household can make deposits in domestic banks or purchase foreign bonds. Households consume a final consumption good produced using a composite of intermediate inputs from monopolistically-competitive SOEs and competitive private firms (POEs). In each sector, firms use capital and labor as inputs for production and borrow from banks or foreign investors to finance working capital.

¹See, for example, Eichengreen et al. (2011), Eichengreen and Leblang (2003), Chinn and Ito (2006), Ju and Wei (2010), and Aoki et al. (2009). See also Wei (2018) for a survey.

²While some heavy industry firms are not state-owned, Chang et al. (2015) find that the share of SOEs in capital-intensive industries has increased steadily since the late 1990s reforms. In practice, large private 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. Throughout the paper, we use the term "SOE" as representative of all sectors that receive favorable credit treatments.

Consistent with empirical evidence, we assume that SOEs have lower productivity on average than POEs (Hsieh and Klenow, 2009).

Our model includes both distortions to capital flows and financial repression. International capital flows are distorted by taxes levied by the government. The government restricts capital outflows by imposing a tax on foreign asset earnings. This capital outflow restriction drives a wedge between domestic deposit rates and the world interest rate. Similarly, the government restricts capital inflows by imposing a tax on repatriated earnings to foreign investors. In addition, foreign debt requires a risk premium, which increases with the size of the debt.³ The capital inflow restrictions and the risk premium drive a wedge between domestic lending rates and the world interest rate.

Financial repression takes the form of directed lending. Banks are required to extend a fraction of their loans to SOEs at below-market interest rates. In contrast, POEs borrow only at market rates. SOEs have the option to borrow beyond the level dictated by directed lending, but they pay market rates on additional borrowing. We assume that the interest rate on directed loans is lower than the deposit rate. Thus, directed lending is unprofitable, and banks can remain solvent only with sufficiently low interest rates on household deposits and high market interest rates. Financial repression therefore drives a wedge between domestic deposit rates and market lending rates.⁴

These distortions lead to resource misallocation, both across sectors and time. Subsidized bank loans to SOEs, combined with restricted POE access to prevailing global borrowing opportunities, encourages SOE activity at the expense of POEs. As POEs are more productive, this depresses aggregate productivity. At the same time, bank losses from directed lending to SOEs depress domestic deposit rates. Households would benefit from the opportunity of saving abroad, but are discouraged from doing so by taxes on capital outflows. This distorts domestic consumption-savings decisions.

Under this framework, we examine the implications of capital account liberalization in the presence of financial repression. Our analysis—based on analytical solutions

³The dependence of the risk premium on the size of the external debt can be interpreted as an upward-sloping supply curve of foreign funds stemming from sovereign risk or costs of portfolio adjustment. As individual firms do not internalize the effects of their borrowing levels on the risk premium, our decentralized equilibrium features an over-borrowing externality similar to that studied by Bianchi (2011).

⁴Explicit directed lending is not as prevalent today in China as it was at the turn of the century, but analogous policy distortions favoring protected sectors remain prevalent (Chen et al., 2017).

and calibrated numerical simulations—highlight the tradeoff between aggregate productivity and intertemporal allocative efficiency, both in the steady state and along a transition path.

The steady-state solution of our model demonstrates an interior optimum for capital account restrictions on both inflows and outflows. For example, consider a permanent relaxation of controls on capital outflows, holding inflow controls constant. Cutting capital outflow taxes enables households to obtain higher earnings on their savings and thus mitigates distortions to their intertemporal consumption-savings decisions. However, domestic banks face increased funding costs and respond by raising market lending rates. Thus, the relative funding costs for POEs rise and resources are shifted from POEs to less productive SOEs. This process exacerbates the misallocation across sectors and reduces aggregate productivity.

Alternatively, consider liberalization of capital inflows in isolation. A lower tax on capital inflows enhances POE access to foreign funding, and thus raises relative POE output and aggregate productivity. However, the foreign inflows lower the market lending rate. Given bank losses on directed lending, the reduction in the market lending rate requires a reduction in deposit rates to maintain bank solvency. The decline in the deposit rate exacerbates the distortions on the households' intertemporal consumption-savings decisions.⁵

For liberalization of both inflow and outflow controls, optimal levels of distortion depend on the severity of financial repression. More severe financial repression calls for stricter controls over both inflows and outflows. When the planner can optimize the degree of financial repression as well, welfare is maximized at positive levels of both financial repression and capital controls. Optimal policy requires some amount of financial repression because, under monopolistic competition, SOE production without directed lending would be inefficiently low.⁶

The tradeoff between aggregate productivity and intertemporal allocative efficiency in the steady-state also carries over to analyzing optimal liberalization policies along the transition path when the economy goes through structural changes. To illustrate

⁵The benefits of relaxing capital inflow controls are also partly offset by the over-borrowing externality associated with the risk premium on foreign debt.

⁶In practice, there are other reasons why the government wants to protect SOEs or heavy industries, such as maintaining employment or providing public goods (Brandt and Zhu, 2000). Modeling these practical considerations is clearly beyond the scope of our paper. We assume monopolistic competition in the SOE sector, which we view as a useful short cut to provide a reason for the government to subsidize SOE activity.

this point, we consider a structural change catalyzed by a decline in the expenditure share of SOE goods, as observed in the Chinese data.⁷ We examine the welfare implications of alternative paces and depths of liberalizing the capital account and financial repression, taking into account the transition dynamics.

Optimal policy calls for gradual capital account liberalization and a relatively fast pace of financial reforms. In the presence of financial repression, liberalizing controls over either inflows or outflows incurs a tradeoff during transition. In particular, while relaxing outflow controls alone benefits households by raising domestic deposit rates, it also raises POE funding costs, and thus reduces aggregate productivity by reallocating resources to less productive SOEs. Alternatively, while relaxing inflow controls alone reduces POE funding costs and improves aggregate productivity, the increased competition from foreign investors pushes down domestic lending rates and forces banks to cut domestic deposit rates, further distorting households' intertemporal consumption-savings decisions. In addition, the increased foreign debt also raises the risk premium, exacerbating the over-borrowing externality. In the more general case where the planner can choose the pace of liberalizing both financial repression and capital controls, optimal policy calls for rapid and deeper reform of the domestic financial system, but more gradual and moderate liberalization of the capital account.

Our model's prediction that an increase in capital inflows should lead to a contraction in the relative activity of SOEs is broadly in line with the impulse responses estimated in a Bayesian VAR (BVAR) model. Figure 1 shows the impulse responses following a positive shock to capital inflows. The BVAR includes four variables: the ratio of capital inflows to GDP, the ratio of private capital outflows to GDP, the ratio of new bank loans to GDP, and the share of SOE investment in aggregate investment, in that order. Under this Cholesky identification assumption, the capital outflows, the bank loans, and the SOE investment share are all allowed to respond to shocks to capital inflows on impact, whereas the capital inflow measure does not respond to the other shocks in the impact period.⁸ Consistent with the model, a shock that raises capital inflows also raises capital outflows, reduces new bank loans, and lowers the SOE investment share.

⁷Chen 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.

⁸The data that we use are quarterly series from 1998:Q1 to 2016:Q4. The SOE investment share is the ratio of SOE investment to aggregate fixed investment taken from Chang et al. (2015). The ratio of new bank loans to GDP is also from Chang et al. (2015). The capital inflow and outflow data are available at China's State Administration of Foreign Exchange (SAFE).

However, our model has ambiguous predictions for the impact of an increase in capital outflows on relative SOE activity. Increasing capital outflows raises domestic market rates and depresses relative POE activity. However, increased outflows also reduces total domestic bank loans that are available for firms in both the SOE and POE sectors, leaving the overall effects on *relative* SOE investment ambiguous, as SOEs disproportionately benefit from increased overall bank lending under financial repression. Figure 2 confirms this intuition for our BVAR model. This model includes the same four variables as above, but with the capital outflows ordered first. A shock that raises capital outflows also raises capital inflows, and it leads to a significant decline in new bank loans, but with a small and insignificant decline in the SOE investment share.

II. RELATED LITERATURE

Our paper contributes to the large literature on capital account distortions. Capital account restrictions can distort domestic financial markets (Edwards, 1999; Jeanne et al., 2012). They can also distort international trade, effectively mimicking an increase in tariffs (Wei and Zhang, 2007; Costinot et al., 2014) or a devaluation of the real exchange rate (Jeanne, 2013).⁹ Chang et al. (2015) demonstrate that China’s costly sterilized intervention program needed to maintain its closed capital account policy constrained domestic monetary policy.¹⁰ Nonetheless, temporary capital account restrictions have been shown to help stabilize large fluctuations in capital inflows (Ostry et al., 2010). However, the welfare effects of such capital flow taxes depend on whether or not policy commitment is available (Devereux et al., 2018). Properly designed, temporary capital account policies can serve as a useful tool to mitigate the effects of external shocks (Farhi and Werning, 2012; Unsal, 2013; Davis and Presno, 2017).

Our work is also related to the literature that is skeptical about the merits of capital account liberalization under financial distortions. 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. Chinn and Ito (2006) argue that capital

⁹However, evidence that capital controls themselves inhibit growth is limited (e.g. Jeanne (2013)).

¹⁰However, by limiting the pressure for capital inflows, capital account restrictions can themselves ease the need for undertaking such costly sterilization activity (Liu and Spiegel, 2015).

account liberalization can be detrimental in countries with insufficiently developed institutions. Ju and Wei (2010) show that capital account liberalization can improve welfare in advanced financial systems, but can have ambiguous effects under poorly-developed financial systems. Similarly, Aoki et al. (2009) demonstrate that, with poorly-developed financial systems, capital account liberalization can potentially lead to welfare-reducing long-run stagnation or short-run drops in employment. Those who do advocate for limiting even short run capital account restrictions therefore often rely on arguments based on potential “secondary improvements” or “discipline effects” for domestic institutions stemming from exposure to foreign competition and standards (Kose et al., 2009; Wei and Tytell, 2004).

Given the ambivalence about the welfare implications of capital account liberalization in the literature, some have argued that China should undertake domestic financial reform prior to liberalizing its capital account [e.g. (Hsu, 2016)].¹¹ Our analysis below provides a theoretical framework that formally illustrates the tradeoffs incurred by capital account liberalization under financial repression.¹²

III. THE MODEL

We consider a small open economy model with overlapping generations. There is a continuum of households, each living 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). SOEs face monopolistically competitive product markets, whereas POEs operate in perfectly competitive markets. Consistent with empirical evidence, SOEs have lower average productivity than POEs. Firms in both sectors rely on bank loans to finance wage and rental payments and they face working capital constraints.

¹¹Similar arguments were made much earlier concerning the proper order of liberalizing the current and capital accounts of an emerging market economy. For example, see Edwards (1984).

¹²Song et al. (2014) study an overlapping generations model with capital controls. They take capital controls as given and examine the implications of several domestic financial liberalization policies. Wang et al. (2015) derive a model in which financial distortions in China result in excessive savings by households and high rates of domestic returns on capital, which leads to two-way capital flows in equilibrium. However, these papers do not study the implications of capital account liberalization, the focus of our paper.

Banks operate in a perfectly competitive market, taking as given the interest rates on deposits and lending. The government provides favorable credit treatment to SOEs by directing banks to lend a minimum share of their available funds to SOEs at below-market interest rates. Banks lend their remaining funds at market interest rates to SOEs or POEs. Under its capital control policy regime, the government also imposes taxes on both capital inflows and outflows.

III.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

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

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

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

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

When young, the household consumes C_t^y , saves bank deposits D_t and foreign investments B_{ft}^d , 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 a lump-sum transfer T_t from the government.¹³ In addition, the young household also receives bequest income Γ_t from the previous old generation, which is a constant fraction Γ of the wealth held by the old. Specifically, the amount of bequest income is given by

$$\Gamma_t = \Gamma \left\{ R_{t-1} D_{t-1} + (1 - \tau_d) R_{t-1}^* B_{f,t-1}^d + d_t + [q_t^k (1 - \delta) + r_t^k] (K_{t-1}^o + I_{t-1}) \right\}. \quad (4)$$

When old, the household consumes the asset holdings, which consist of interest earnings on deposits $R_t D_t$, after-tax earnings on foreign investment $(1 - \tau_d) R_t^* B_{ft}^d$, dividend income d_{t+1} from firms that the household owns, and the returns from capital

¹³Outcomes are invariant to whether transfers are made to the young or the old.

investment. The old household also leaves bequests Γ_{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 τ_d is a tax on foreign investment earnings (i.e., capital outflows).

The optimizing conditions are summarized by the following equations:

$$\Lambda_t^y = \frac{1}{C_t^y}, \quad (5)$$

$$\Lambda_t^o = \frac{1}{C_t^o}, \quad (6)$$

$$w_t = \frac{\Psi H_t^\eta}{\Lambda_t^y}, \quad (7)$$

$$1 = E_t \beta R_t \frac{\Lambda_{t+1}^o}{\Lambda_t^y}, \quad (8)$$

$$1 = E_t \beta (1 - \tau_d) R_t^* \frac{\Lambda_{t+1}^o}{\Lambda_t^y}, \quad (9)$$

$$q_t^k + \frac{\Omega_k}{2} \left(\frac{I_t}{K_t^o} - \frac{\bar{I}}{\bar{K}^o} \right)^2 - \Omega_k \left(\frac{I_t}{K_t^o} - \frac{\bar{I}}{\bar{K}^o} \right) \frac{I_t}{K_t^o} = E_t \beta [q_{t+1}^k (1 - \delta) + r_{t+1}^k] \frac{\Lambda_{t+1}^o}{\Lambda_t^y}, \quad (10)$$

$$1 + \Omega_k \left(\frac{I_t}{K_t^o} - \frac{\bar{I}}{\bar{K}^o} \right) = E_t \beta [q_{t+1}^k (1 - \delta) + r_{t+1}^k] \frac{\Lambda_{t+1}^o}{\Lambda_t^y}, \quad (11)$$

where Λ_t^y and Λ_t^o denotes the Lagrangian multiplier for the two budget constraints. Equations (8) and (9) imply the no-arbitrage condition that

$$R_t = (1 - \tau_d) R_t^*. \quad (12)$$

A positive tax rate τ_d captures capital outflow controls. Thus, capital outflow controls drive a wedge between the domestic deposit rate and the world interest rate.

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

$$K_t = K_t^o + I_t, \quad (13)$$

and

$$K_t^o = (1 - \delta) K_{t-1}. \quad (14)$$

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

$$K_t = (1 - \delta) K_{t-1} + I_t. \quad (15)$$

III.2. The final good sector. Final goods are produced using intermediate goods supplied from the two sectors: SOE and POE. The production function is given by

$$Y_t = \left(\phi_t Y_{st}^{\frac{\sigma_m-1}{\sigma_m}} + (1 - \phi_t) Y_{pt}^{\frac{\sigma_m-1}{\sigma_m}} \right)^{\frac{\sigma_m}{\sigma_m-1}}, \quad (16)$$

where Y_t denotes the final good output, Y_{st} and Y_{pt} denote the intermediate input produced in the SOE sector and POE sector, respectively, σ_m denotes the elasticity of substitution between intermediate goods produced by the two sectors, and the term $\phi_t \in (0, 1)$ measures the expenditure share of SOE goods used in final goods production. We allow the SOE share to be time varying because we would like to study the implications of capital account liberalization when the economy is going through structural changes. We focus the structural change associated with a steady decline in the SOE share, as observed in China's data.

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

$$Y_{st} = p_{st}^{-\sigma_m} \phi_t^{\sigma_m} Y_t, \quad Y_{pt} = (1 - \phi_t)^{\sigma_m} p_{pt}^{-\sigma_m} Y_t. \quad (17)$$

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

$$1 = \phi_t^{\sigma_m} p_{st}^{1-\sigma_m} + (1 - \phi_t)^{\sigma_m} p_{pt}^{1-\sigma_m}. \quad (18)$$

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

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

$$Y_{jt} = A_j (K_{jt})^{1-\alpha} (H_{jt})^\alpha, \quad (19)$$

where A_j 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.

Firms face working capital constraints. Before production takes place, a firm needs to pay wages and capital rents with working capital loans B_{jt} obtained from banks, at the interest rate R_{jt} . The firm repays the loans at the end of the period when production is completed. The working capital constraint for a firm in sector $j \in \{s, p\}$ is given by

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

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 by ϵ_j the elasticity of substitution between products produced by different firms within sector j . Our market structure assumption implies that the elasticity is finite for the SOE sector, but infinite for the POE sector.

Given these elasticities, a firm's cost-minimizing decisions in sector j imply the conditional factor demand functions

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

and

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

Since SOE firms face monopolistic competition, the term $\frac{\epsilon_s}{\epsilon_s - 1} > 1$ represents the price markup. Since POE firms 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

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

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

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

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

III.4. Banks. There is a continuum of competitive banks. The representative bank takes deposits from households at the deposit interest rate R_t and lends to firms in the SOE and POE sectors. To capture financial repression in China, we assume that the government requires the bank to lend a minimum fraction of its loanable funds, $\gamma \in [0, 1)$, to SOEs at a below-market interest rate, which we normalize to zero. The bank lends its remaining funds to domestic firms at the market loan rate R_{lt} .

Denote by B_{gt} the amount of directed lending to SOEs and B_t the remaining funds that the bank lends at the market interest rate. The directed lending policy implies

that

$$B_{gt} \geq \gamma(B_{gt} + B_t), \quad (25)$$

note that γ also indicates the severity of financial repression.

The representative bank maximizes its profits

$$B_{gt} + R_{lt}B_t - R_tD_t \quad (26)$$

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

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

Since banks are risk neutral and there is free entry, the representative bank earns zero profits in equilibrium. The zero-profit condition leads to

$$R_t = \gamma + (1 - \gamma)R_{lt}. \quad (28)$$

Thus, $R_{lt} > R_t$ if and only if $\gamma > 0$, which holds under financial repression. Financial repression drives a wedge between the loan rate and the deposit rate, as the bank must charge an interest rate R_{lt} on market lending that exceeds the deposit interest rate R_t to break even.

III.5. Foreign investors. Foreign investors can lend to domestic firms at the market loan rate R_{lt} .¹⁴ We assume that foreign investors are subject to an investment income tax τ_l , so that their after-tax return on loans to Chinese firms is $(1 - \tau_l)R_{lt}$.

External borrowing is subject to a risk premium, $\Phi\left(\frac{B_{ft}^l}{Y_t}\right)$, which is an increasing function of the ratio of external debt (B_{ft}^l) to aggregate output (Y_t). Under these assumptions, no arbitrage implies that

$$(1 - \tau_l)R_{lt} = R_t^* \Phi\left(\frac{B_{ft}^l}{Y_t}\right). \quad (29)$$

The dependence of the risk premium on the relative size of external debts generates a spillover externality that leads to over-borrowing. Since individual firms take the loan interest rate (inclusive of the risk premium) as given, they do not internalize the effects of collective borrowing on the risk premium. The presence of the capital inflow tax and the risk premium drives a wedge between domestic loan interest rate and the world interest rate.

¹⁴In principle, foreign investors could also access China's financial market by depositing funds at Chinese banks. However, under capital outflow controls, the deposit interest rate lies below the world interest rate (see Eq. (12)) and foreign investors would not do this in equilibrium.

III.6. Market clearing and equilibrium. An equilibrium consists of sequences of allocations $\{C_t^y, C_t^o, I_t, K_t^o, Y_t, K_{st}, K_{pt}, H_{st}, H_{pt}, K_t, H_t, B_{st}, B_{pt}, B_{gt}, B_t, B_{ft}^l, NX_t\}$ and prices $\{w_t, R_t, q_t^k, r_t^k, p_{st}, p_{pt}, R_{st}, R_{pt}, R_{lt}\}$ that solve the optimizing problems for the households, the firms, and the banks. In the equilibrium, the markets for the loanable funds, capital, labor, and goods all clear.

The loan market clearing condition is given by,

$$B_{st} + B_{pt} = B_{gt} + B_t + B_{ft}^l. \quad (30)$$

Capital and labor are both perfectly mobile across sectors, so that the labor market and the capital market clearing implies that

$$H_t = H_{st} + H_{pt}, \quad (31)$$

and

$$K_{t-1} = K_{st} + K_{pt}. \quad (32)$$

Final goods market clearing implies that the trade surplus is given by

$$NX_t = Y_t - C_t^y - C_t^o - I_t - \frac{\Omega_k}{2} \left(\frac{I_t}{K_t^o} - \frac{\bar{I}}{\bar{K}^o} \right)^2 K_t^o. \quad (33)$$

In addition, by summing up all sectors' budget constraints, we obtain the balance of payments condition

$$NX_t + (R_{t-1}^* - 1)B_{f,t-1}^d - \left[R_{t-1}^* \Phi \left(\frac{B_{f,t-1}^l}{Y_{t-1}} \right) - 1 \right] B_{f,t-1}^l = (B_{ft}^d - B_{ft}^l) - (B_{f,t-1}^d - B_{f,t-1}^l) + \Delta_t. \quad (34)$$

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 banks receive repayments on their working capital loans at the end of the same period, whereas they repay deposits to the households at the beginning of the next period.

IV. POLICY DISTORTIONS AND FACTOR ALLOCATIONS: SOME ANALYTICAL RESULTS

This section provides some analytical characterizations of the implications of capital controls and directed lending for steady-state resource allocations and aggregate productivity.

To keep the analytics tractable, we focus on a Cobb-Douglas production function for the final goods sector, given by

$$Y = Y_s^\phi Y_p^{1-\phi}, \quad (35)$$

where ϕ is the expenditure share of SOE goods. This is a special case of the CES aggregation technology Eq. (16) with $\sigma_m = 1$. The cost-minimizing solution (17) for the final goods producer becomes

$$Y_s p_s = \phi Y, \quad Y_p p_p = (1 - \phi)Y. \quad (36)$$

We assume that the risk-premium function takes the form

$$\Phi \left(\frac{B_{ft}^l}{Y_t} \right) = \exp \left[\Phi_b \left(\frac{B_{ft}^l}{Y_t} - \kappa_f \right) \right], \quad (37)$$

where the parameter Φ_b measures the elasticity of the risk premium to the ratio of external debts to output and the term κ_f is a constant. Given this functional form of the risk premium, the no-arbitrage condition (29) implies that the ratio of foreign capital inflows to output is given by

$$b_f \equiv \frac{B_{ft}^l}{Y_t} = \kappa_f + \frac{1}{\Phi_b} \ln \left[\frac{(1 - \tau_l) R_l}{R^*} \right]. \quad (38)$$

We examine the steady-state implications of capital controls and financial repression for resource allocations between the SOE sector and the POE sector and also for aggregate productivity. We focus on the interior equilibrium with positive gross capital flows (both inflows and outflows). Denote by $S(\tau_d, \tau_l, \gamma) \equiv \frac{K_s}{K_p}$ the ratio of capital used by the SOE sector to that by the POE sector, which is a function of the policy parameters τ_d , τ_l , and γ .

The cost-minimizing solutions (21) and (22) for the intermediate goods producing firms imply that the labor input ratio across sectors is identical to the capital input ratio (i.e., $\frac{H_s}{H_p} = \frac{K_s}{K_p} = S(\tau_d, \tau_l, \gamma)$.) Thus, we focus on $S(\tau_d, \tau_l, \gamma)$ as a measure for resource allocations across the sectors.

Using the cost-minimizing solution for the final goods sector in Eq. (36) and those for the intermediate goods sectors in Eq. (21) and (22), we obtain

$$S(\tau_d, \tau_l, \gamma) = \frac{K_s}{K_p} = \frac{R_p}{R_s} \frac{\phi}{1 - \phi} \frac{1}{\mu_s}, \quad (39)$$

where $\mu_s = \frac{\epsilon_s}{\epsilon_s - 1}$ denotes the SOE markup.

The funding cost for POEs is just the market loan rate, so that $R_p = R_l$, which is in turn related to the deposit interest rate R through the banks' break-even condition (28), so that $R_l = \frac{R - \gamma}{1 - \gamma}$. In the interior equilibrium, we have

$$R = (1 - \tau_d)R^*, \quad R_l = \frac{(1 - \tau_d)R^* - \gamma}{1 - \gamma}. \quad (40)$$

This relation implies that tightening of capital outflow controls (increasing τ_d) depresses domestic interest rates, while increasing financial repression (raising γ) widens the wedge between the lending rate and the deposit rate.

Liberalization policy acts through firm funding costs. An SOE firm has access to directed lending, B_g , as well as the option to borrow at the market interest rate if its working capital demand exceeds the amount of directed loans. Thus, the effective funding cost for SOEs (R_s) is given by

$$R_s = \frac{B_g + R_l(B_s - B_g)}{B_s}, \quad (41)$$

where B_s is the total amount of SOE loans, consisting of both the directed lending, B_g , at zero interest and market loans, $B_s - B_g$, at the market loan rate.

With some algebra, we can show that the relative size of the SOE sector, measured by the share of capital (or labor) used by SOEs $S(\cdot)$, is given by¹⁵

$$S(\tau_d, \tau_l, \gamma) = \frac{\phi}{1 - \phi} \left[\frac{1}{\mu_s} + \frac{R - 1}{R} \frac{\gamma}{1 - \gamma} \frac{1}{\phi} \left(1 - \frac{\phi}{\epsilon_s} - R_l b_f \right) \right], \quad (42)$$

where the interest rates R and R_l are related to the policy parameters through Eq. (40) and the ratio of capital inflows to output, b_f , is related to the interest rates and therefore the policy parameters through Eq. 38.

IV.1. Controls on capital outflows and factor allocations. We now examine how changes in capital outflow tax rate τ_d affect the share of capital allocated to the SOE sector measured by $S(\cdot)$.

Using Equations (38), (40), and (42), it is straightforward to show that

$$\frac{\partial S}{\partial \tau_d} = -\frac{R^*}{R} \frac{\gamma}{1 - \gamma} \frac{1}{1 - \phi} \frac{D}{Y} + \frac{R - 1}{R} \frac{\gamma}{1 - \gamma} \frac{R^*}{1 - \phi} \left(\frac{1}{1 - \gamma} b_f + \frac{1}{\Phi_b} \frac{1}{R - \gamma} \right), \quad (43)$$

where $\frac{D}{Y} = \frac{1}{R} \left(1 - \frac{\phi}{\epsilon_s} - R_l b_f \right)$ is the deposit-to-output ratio.

The first term in the expression for $\frac{\partial S}{\partial \tau_d}$ is negative, suggesting that a relaxation of capital outflow controls (i.e., a decline in τ_d) raises domestic interest rates, shifting resources towards the SOE sector. This happens because SOE funding costs are less sensitive to changes in market lending rates under financial repression. The second term is positive, implying that a reduction in outflow taxes and the resulting increase in domestic lending rates attract capital inflows, benefiting POEs more than SOEs.

¹⁵Detailed derivations of these results are shown in the Appendix.

The relative strength of the capital-inflow channel (the second term in equation (43)) depends on the level of τ_d . Under a lower level of τ_d , domestic interest rates and capital inflows (b_f) are higher in the steady state. As a result, the capital-inflow effects on resource reallocations would be more likely to dominate, and a reduction in capital outflow taxes would likely reallocate resources to the POE sector. However, at higher values of τ_d , the inflow channel would be more muted. In the extreme with $\tau_d = 1 - \frac{1}{R^*}$, the domestic interest rate is forced down to zero ($R = 1$) and the second term in equation (43) is equal to 0. In that case, a relaxation of capital outflow controls unambiguously raises the share of resources allocated to the SOE sector.

The following proposition summarizes these results.

Proposition IV.1. *For given values of τ_l and γ , there exists a threshold value of the capital outflow tax rate $\bar{\tau}_d \in (-\infty, 1 - \frac{1}{R^*})$, such that the relative size of the SOE sector measured by $S(\tau_d, \tau_l, \gamma)$ increases with τ_d if and only if $\tau_d \leq \bar{\tau}_d$.*

Proof. We provide a proof in the Appendix. □

Proposition IV.1 suggests that, holding other policy parameters constant, lowering capital outflow taxes can reduce the size of the SOE sector, except provided that the initial outflow tax rate is sufficiently small.

IV.2. Capital inflow controls and factor allocations. Holding τ_d and γ constant, a reduction in capital inflow taxes (τ_l) unambiguously benefits the POEs more than the SOEs, as it impacts directly on market lending rates, to which POE funding costs are more sensitive. Thus, cutting capital inflow taxes leads to a reallocation of capital and labor from the SOEs to the POEs. This result is formally stated in the proposition below.

Proposition IV.2. *For given values of τ_d and γ , the relative size of the SOE sector $S(\tau_d, \tau_l, \gamma)$ increases with τ_l .*

Proof. Differentiating Eq. (42) with respect to τ_l , we obtain

$$\frac{\partial S}{\partial \tau_l} = \frac{R-1}{R} \frac{\gamma}{1-\gamma} \frac{1}{1-\phi} R_l \frac{1}{\Phi_b} \frac{1}{1-\tau_l} > 0. \quad (44)$$

□

IV.3. Financial reform and factor allocations. We next examine the effects of changes in financial repression (γ) on factor allocations across the two sectors. From

Eq. (42), we can obtain

$$\frac{\partial S}{\partial \gamma} = (R-1) \frac{1}{1-\phi} \frac{1}{(1-\gamma)^2} \frac{D}{Y} - \frac{R-1}{R} \frac{\gamma}{1-\gamma} \frac{1}{1-\phi} \frac{R-1}{(1-\gamma)^2} \left(b_f + \frac{1}{\Phi_b} \right). \quad (45)$$

Reducing financial repression lowers the market lending rate, lowering POE funding costs and reallocating capital and labor from SOEs to POEs (the positive term in Eq. (45)). However, the decline in the market interest rate discourages foreign capital inflows, hurting POEs more than SOEs (the negative term in (45)). Thus, the net effect of a decline in γ on the relative size of the SOE sector $S(\cdot)$ depends on the initial value of γ . A small value of γ weakens the capital inflow effect, implying that $\frac{\partial S}{\partial \gamma} > 0$. A large value of γ has the opposite impact. The following proposition formalizes this result.

Proposition IV.3. *For any given values of $\tau_l < 1$ and $\tau_d < 1 - \frac{1}{R^*}$, there exists a threshold value $\bar{\gamma} \in (0, 1)$, such that the relative size of the SOE sector $S(\tau_d, \tau_l, \gamma)$ increases with γ if and only if $\gamma \leq \bar{\gamma}$.*

Proof. We provide a formal proof in the Appendix. □

IV.4. Sectoral allocations and aggregate productivity. To understand how policy reforms (i.e., changes in τ_d , τ_l , and γ) can affect aggregate productivity, we need first to understand how productivity is related to sectoral allocations. Firms in the SOE sector have lower average productivity than those in the POE sector, so an increase in the relative size of the SOE sector ($S(\cdot)$) might cause misallocations and reduce aggregate productivity. However, as SOE goods and POE goods are imperfect substitutes, there should be positive output in the SOE sector as well, despite its lower productivity.

Define the aggregate total factor productivity (TFP) by

$$\tilde{A} = \frac{Y}{K^\alpha H^{1-\alpha}}. \quad (46)$$

Using the factor market clearing conditions that $K = K_s + K_p$ and $H = H_s + H_p$ and the Cobb-Douglas technology for final goods production in equation (35), aggregate TFP (\tilde{A}) can be expressed as a function of the relative size of the SOE sector given by

$$\tilde{A} = A_s^\phi A_p^{1-\phi} \frac{S^\phi}{1+S}, \quad (47)$$

where A_s and A_p denote the exogenous levels of productivity in the SOE and POE sectors, respectively.

Differentiating \tilde{A} with respect to S in equation (47), we obtain

$$\begin{aligned}\frac{\partial \tilde{A}}{\partial S} &= \tilde{A} \frac{1-\phi}{S(1+S)} \left[\frac{\phi}{1-\phi} - S \right] \\ &= \tilde{A} \frac{1-\phi}{S(1+S)} \frac{\phi}{1-\phi} \left[1 - \frac{1}{\mu_s} - (R-1) \frac{\gamma}{1-\gamma} \frac{1}{\phi} \frac{D}{Y} \right],\end{aligned}\quad (48)$$

where we have used the expression for S in equation (42) and the relation $\frac{D}{Y} = \frac{1}{R} \left(1 - \frac{\phi}{\epsilon_s} - R_l b_f \right)$.

Thus, an increase in S raises TFP if and only if $S < \frac{\phi}{1-\phi}$; or equivalently, if and only if the share of capital (or labor) inputs allocated to the SOE sector is smaller than the expenditure share on SOE products. Since the markup tends to keep SOE output inefficiently low, a reduction in the relative size of the SOE sector can improve aggregate TFP only if the markup is sufficiently small.

This result is formally stated in the following proposition.

Proposition IV.4. *For any given policy configuration (τ_d, τ_l, γ) , there exists a threshold level of SOE markup $\bar{\mu}_s > 1$ such that aggregate TFP (\tilde{A}) decreases with S if and only if $\mu_s < \bar{\mu}_s$. The threshold markup is given by*

$$\bar{\mu}_s \equiv \left[1 - (R-1) \frac{\gamma}{1-\gamma} \frac{1}{\phi} \frac{D}{Y} \right]^{-1}.\quad (49)$$

Proof. The proposition follows immediately from Equation (48). \square

V. CALIBRATION

We illustrate the tradeoffs incurred by liberalizing the capital account under financial repression based on numerical solutions to the model with calibrated parameters shown in Table 1. Where possible, we calibrate our model based on values from the Chinese economy.

We set the subjective discount factor to $\beta = 0.665$, which implies an annualized discount factor of 0.96 since we interpret a period in our model as 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 the capital adjustment cost parameter to $\Omega_k = 5$, which lies in range of the empirical estimates in 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 , the share of the old-age income bequest to 0.75, implying an annual household consumption to net worth ratio $\frac{C^y+C^o}{10(D+B_f^d+q_kK)}$ of 7%, consistent with the 2011 China Household Finance Survey. We set the elasticity of substitution between SOE output and POE output to $\sigma_m = 3$, which lies in the range estimated by Chang et al. (2015).¹⁶

For the parameters related to intermediate goods producers, we calibrate the labor income share to $\alpha = 0.5$ based on the empirical evidence documented by Brandt et al. (2008) and Zhu (2012). We set the elasticity of substitution between differentiated products produced by SOE firms to $\epsilon = 20$, implying an average gross output markup of 5%, which is consistent with the average spread in profit margins between SOEs and POEs. We normalize the scale of SOE total factor productivity (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). In our transition analysis, we vary the expenditure share of SOE goods ϕ to capture structural changes in China. We set $\phi = 0.5$ in the initial steady state and consider a lower value of $\phi = 0.3$ for the new steady state. These values of ϕ are broadly in line with the observed declines in the SOE share in China's industrial output from 2000 to 2010, as documented by Chen et al. (2017).

For the policy parameters, we set the baseline share of directed lending $\gamma = 0.5$. 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 loans to SOEs were directed lending at subsidized interest rates, so a value of $\gamma = 0.5$ seems plausible. We set the baseline capital outflow tax rate to $\tau_d = 16.63\%$. This value implies that $\frac{B_{ft}^d}{Y_t} = 0.06$ in the initial steady state, consistent with the average ratio of domestic private holdings of foreign assets to aggregate output in the Chinese data for the period from 2004 to 2017. We set the baseline capital inflow tax rate to $\tau_l = 5.08\%$, so that the steady-state ratio of foreign debt to aggregate output is $\frac{B_{ft}^l}{Y_t} = 0.04$. This ratio is consistent with the Chinese data. In particular, according to the 2016 Annual Report of the State Administration of Foreign Exchange (SAFE) of China, the ratio of China's foreign liabilities to its annual GDP stayed roughly constant, and averaged about 40% from 2006 to 2016.¹⁷ We set the targeted steady-state foreign debt-to-output ratio to $\kappa_f = 0.04$, such that

¹⁶Chang et al. (2015) estimate that the elasticity of substitution between SOE and POE outputs is about 4.53 if annual output data are used. The estimated elasticity is about 1.92 if monthly sales are used to measure output.

¹⁷See Table S3, "China's International Investment Position, 2004-2016" in the SAFE report.

the risk premium on external debt is zero in the initial steady state equilibrium under the baseline policy. When the economy deviates from the initial steady state, however, the value of κ_f stays constant whereas the foreign debt-to-output ratio varies endogenously. We set the risk premium parameter on foreign debt to $\Phi_b = 3$, which is consistent with the elasticity of emerging market sovereign bond spread to external debt-to-GDP ratio estimated by Bellas et al. (2010).

VI. CAPITAL ACCOUNT LIBERALIZATION: COMPARATIVE STATICS

We now use the calibrated model to examine the implications of alternative liberalization policies for equilibrium allocations and welfare. Through this analysis, we highlight the tradeoff between aggregate productivity and intertemporal allocative efficiency that arises when the capital account is liberalized under financial repression.

We first take financial repression as given, and consider three alternative capital account liberalization policies: (i) a one-way liberalization of capital outflows, (ii) a one-way liberalization of capital inflows, and (iii) liberalizing controls over both capital outflows and inflows. We then examine the implications of joint liberalization of both financial repression and capital controls. We focus on the steady state analysis throughout this section.

VI.1. Liberalizing capital outflow controls. We begin by examining the steady-state implications of a one-way liberalization of controls on capital outflows by reducing the capital outflow tax rate τ_d , while holding the inflow tax rate τ_l and the financial repression parameter γ constant.

To help develop intuition, we first consider the extreme case in which capital inflows are prohibited (by setting $\tau_l = 100\%$). Figure 3 shows the relation between steady-state equilibrium variables (the vertical axis in each panel) and the capital outflow tax rate τ_d (the horizontal axis). Foreign debt is zero in this extreme case with prohibitive capital inflow taxes. If τ_d is sufficiently high, households will not invest abroad, so that the economy will be in a financial autarky. When τ_d declines sufficiently, however, households begin to invest a fraction of their savings abroad, raising foreign asset holdings while reducing domestic bank deposits. No arbitrage implies that the domestic deposit interest rate rises to the level of the after-tax returns on foreign assets. The increased asset returns alleviate the distortion on the households' consumption-savings decisions.

However, under financial repression (i.e., a positive γ), banks must respond to the increase in the deposit interest rate by also raising the market lending interest rate

in order to remain solvent. This increase in the market lending rate has a larger impact on POE firms than on SOE firms, because a portion of SOE borrowing takes place at below-market interest rates through directed lending. Liberalizing capital outflow controls therefore reallocates resources from POEs to less productive SOEs, exacerbating misallocation and reducing aggregate TFP, as shown in the Figure.

Therefore, relaxing capital outflow controls improves intertemporal allocative efficiency, but exacerbates the misallocation across sectors. If the initial outflow tax is high (i.e., if the economy is close to financial autarky), easing outflow controls improves welfare because the improvement in intertemporal allocations dominates the cross-sector misallocation effect. If the initial outflow tax is sufficiently low, then the opposite is true, and further liberalizing capital outflow controls reduces welfare. The second-best capital control policy has an interior optimum, with a positive τ_d that maximizes steady-state welfare. Under our calibration (and assuming $\tau_l = 100\%$), the optimal outflow tax rate is $\tau_d^* = 9\%$, as shown in the last panel of the figure.

In the more general case where capital inflows are also allowed to adjust (with the inflow tax calibrated to $\tau_l = 5.08\%$), our qualitative results remain the same (Figure 4). Reducing τ_d raises the domestic market lending rate. When the lending rate rises sufficiently, foreign investors begin to lend to domestic firms. Thus, both foreign assets and foreign liabilities increase. As shown in Figure 4, we continue to observe a tradeoff between the positive intertemporal allocative effect and the negative misallocation effect, and thus we again obtain an interior second-best optimum for the capital outflow tax. The difference is that, when capital inflows are allowed, the decline in aggregate TFP is smaller and welfare is higher at this optimum. This result is driven by the availability of foreign funds at higher domestic rates, which mitigates the misallocation effect. At very low capital outflow tax rates, further liberalization reverses the TFP decline. Overall, the tradeoff between aggregate productivity and intertemporal efficiency still results in an interior optimum for capital outflow taxes, but one with higher welfare.

VI.2. Liberalizing capital inflow controls. Consider now the effects of liberalizing capital inflow controls by reducing the tax rate τ_l on foreign investors' earnings. Again, we first illustrate the mechanism using the special case with no capital outflows (achieved by setting $\tau_d = 1$), and then consider the more general case with outflows allowed by setting τ_d at its calibrated value.

Figure 5 displays the relationship between the steady-state capital inflow tax (τ_l) and several macroeconomic variables in the case without capital outflows (with $\tau_d =$

100%). If the inflow tax rate is sufficiently high, then foreign investors do not enter the domestic market and the country is in financial autarky. Liberalizing inflow controls sufficiently raises foreign investors' after-tax returns and induces foreign inflows. These foreign reduce domestic market lending rates. Under directed lending, banks can remain solvent only if they cut their deposit interest rates, exacerbating the distortion on the households' intertemporal consumption-savings decision.

The decline in the market lending rate disproportionately benefits the POEs. SOEs are less sensitive to changes in the market lending rate because directed lending rates are unchanged. As a result, relative POE activity expands, improving aggregate productivity. This positive reallocation effect, however, is partly offset by the over-borrowing externality, because the risk premium on foreign debt increases.

Overall, liberalizing capital inflow controls improves aggregate productivity, but it exacerbates intertemporal misallocation and the over-borrowing externality. The net effect on welfare is thus ambiguous. Figure 5 shows a hump-shaped relation between welfare and the capital inflow tax, with welfare maximized at $\tau_l^* = 11\%$, as shown in Figure 5.

In the more general case with positive capital outflows,¹⁸ the qualitative results are similar (Figure 6). With a sufficiently high inflow tax rate ($\tau_l \geq 10\%$), domestic deposit rates are high, and households choose not to divert their deposits abroad. However, if the tax rate on capital inflows is sufficiently low (with $\tau_l < 10\%$), competition from foreign investors reduces market lending rates, forcing domestic banks to cut deposit rates to remain solvent. Households respond to the decline in deposit rates by purchasing more foreign assets, leading to capital outflows. Overall, liberalizing capital inflow controls in this environment also raises the tradeoffs between improvements in aggregate productivity and increased distortion to intertemporal allocations and the over-borrowing externality. As shown in Figure 6, the representative household's steady-state welfare has a hump-shaped relation with τ_l and reaches its maximum at $\tau_l^* = 2\%$. Since capital outflows are allowed, the maximum obtainable welfare level is higher than in the extreme case with prohibitive capital outflow taxes.

VI.3. Two-way capital account liberalization. We next examine the steady-state implications of liberalizing capital controls for both inflows and outflows (parameterized by τ_l and τ_d), taking different values of financial repression (γ) as given.

Figure 7 shows that more severe financial repression raises optimal restrictions on both capital inflows and outflows. An increase in γ requires an increase in the

¹⁸This case is achieved by setting outflow taxes at their calibrated values of 16.63%.

market lending rate to keep banks solvent. This is partially achieved through an increase in inflow taxes (τ_l). The increased market lending rates reallocate activity towards the less productive SOE sector, lowering TFP. The planner therefore also raises the capital outflow tax (τ_d) to partly undo this misallocation effect, because more restrictive capital outflow controls help retain domestic household deposits and contain domestic lending rates. However, the increase in the market interest rate also increases borrowing from abroad, raising the risk premium and the over-borrowing externality. The planner partly addresses this source of inefficiency by also raising the capital inflow tax rate τ_l , as shown in Figure 7.

Under optimal steady-state capital controls, there is therefore a hump-shaped relation between obtainable welfare under optimal capital control policy and the degree of financial repression γ . When the share of directed lending is high, lowering that share increases aggregate TFP through reallocation across sectors. Reducing directed lending also benefits households because they receive higher returns on savings at domestic banks. In addition, the planner optimally lowers the taxes on capital inflows and outflows. Thus, when γ is initially at a high level, reducing financial repression raises welfare. However, the optimal level of γ is positive because monopolistic competition in the SOE sector leads to inefficiently low levels of SOE production at very low levels of γ . In this range, lowering γ further can actually reduce welfare.

VII. CAPITAL ACCOUNT LIBERALIZATION: TRANSITION DYNAMICS

The Chinese economy has gone through large structural changes over the past two decades. One remarkable structural change is the steady decline in the share of SOE output in total industrial revenue, which declined from about 50% in 2000 to about 30% in 2010, and further to about 20% by 2016 (Chang et al., 2015). In this section, we investigate the optimal path for transition under these structural changes by considering a counterfactual experiment in which the share of SOE input ϕ falls from $\phi_0 = 0.5$ in period zero (the initial steady-state value) to $\phi_1 = 0.3$ in period $t = 1$ and stays at that level thereafter (the new steady-state value). In particular, we examine the optimal magnitude and speed of capital account liberalization that maximizes social welfare along the transition path between these values.

To illustrate our counterfactual policy experiments, consider first the case with capital outflow liberalization. Denote by τ_{d0} the pre-liberalization tax rate on capital outflows; that is, the tax rate in the initial steady state with the high level of the SOE expenditure share. Denote by τ_{d1} the post-liberalization tax rate on capital outflows.

We assume that the government pursues its liberalization policy at a pace measured by $\alpha_d \in [0, 1]$. The transition path of the capital outflow tax rate is then given by

$$\tau_{dt} = \begin{cases} \tau_{d0}, & \text{if } t = 0, \\ \tau_{d0} + (\tau_{d1} - \tau_{d0})[1 - (1 - \alpha_d)^t] & \text{if } t \geq 1. \end{cases} \quad (50)$$

Similarly, denote the pre- and post-liberalization capital inflow tax rates by τ_{l0} and τ_{l1} , respectively, and the pace of capital inflow liberalization by α_l . We also denote the pre- and post-liberalization financial repression by γ_0 and γ_1 respectively, and the pace of financial liberalization by α_γ .

Given these notations, we define the transition welfare as

$$V_1(\tau_{d1}, \tau_{l1}, \gamma_1; \alpha_d, \alpha_l, \alpha_\gamma) = \sum_{t=1}^{\infty} \beta^t \left(\ln(C_t^y) - \Psi_h \frac{H_t^{1+\eta}}{1+\eta} + \ln(C_t^o) \right), \quad (51)$$

where C_t^y and C_t^o denote the consumption of the young and the old, and H_t the labor supply of the young generation, along the transition path. The transition welfare V_1 depends on both the magnitude of the new policy parameters $(\tau_{d1}, \tau_{l1}, \gamma_1)$ and the pace of liberalization $(\alpha_d, \alpha_l, \alpha_\gamma)$.

Table 2 shows the policy parameters and the welfare gains under several alternative policy liberalization scenarios relative to the benchmark policy regime (Case 0).

The first liberalization scenario (Case 1) focuses on liberalizing capital inflow controls and financial repression, while keeping the capital outflow tax rate at its initial steady-state level. The planner chooses both the magnitude and the pace of capital inflow liberalization (τ_{l1} and α_l) and domestic financial reforms (γ_1 and α_γ) to maximize the transition welfare defined in (51). Under this policy, the share of directed lending to SOEs falls sharply from $\gamma_0 = 50\%$ to $\gamma_1 = 0.82\%$ in the new steady state and the financial reform is implemented immediately ($\alpha_\gamma = 100\%$). The planner also chooses to modestly subsidize capital inflows ($\tau_{l1} = -5.32\%$) in the new steady state, although the liberalization of capital inflows is implemented at a gradual pace ($\alpha_l = 20.68\%$).

By cutting directed lending sharply, the financial reform reduces the domestic market lending rate and thus lowers POE funding costs. This improves capital allocation, raises aggregate TFP, and accelerates the transition.¹⁹ However, the decline in the domestic lending rate also discourages foreign capital inflows. The modest new steady state subsidy on capital inflows mitigates their decline under financial liberalization.

¹⁹The share of directed lending under the liberalization policy is slightly positive (at 0.82%) because of the SOE monopoly distortion.

Relative to the benchmark regime, this set of policy reforms leads to a welfare gain of about 28.54% in consumption equivalent units along the transition paths.

The second liberalization scenario (Case 2) focuses on liberalizing capital outflow controls and financial repression, holding the capital inflow tax rate at its initial steady-state level. In particular, the planner chooses the magnitude and the pace of capital outflow liberalization (τ_{l1} and α_l) and financial reforms (γ_1 and α_γ) to maximize the transition welfare, taking as given the inflow taxes. Similar to the case with inflow liberalization, the planner chooses to eliminate financial repression at a fast pace ($\alpha_\gamma = 98\%$), and to implement a small subsidy for capital outflows ($\tau_{d1} = -1.05\%$) at a more gradual pace ($\alpha_d = 46.42\%$). The financial reform helps reduce POE funding costs, and thus improves aggregate productivity and accelerates the transition. The capital outflow subsidy raises the returns on household savings, alleviating intertemporal distortions. This set of reforms improves welfare relative to the benchmark regime, with a transition welfare gain of about 31.27% in consumption equivalent units.

The third liberalization scenario (Case 3) features full reforms, with all the policy parameters chosen optimally to maximize transition welfare. Similar to the partial reforms in Cases 1 and 2, the planner sharply reduces the share of directed lending ($\gamma_1 = 0.78\%$ vs. $\gamma_0 = 50\%$) and implements the financial reform immediately ($\alpha_\gamma = 100\%$). The planner also chooses to relax capital controls by reducing the inflow tax rate ($\tau_{l1} = 3.37\%$ vs. $\tau_{l0} = 5.08\%$) and reducing capital outflow taxes beyond 0 to a very small subsidy ($\tau_{d1} = -0.74\%$ vs. $\tau_{d0} = 16.63\%$). While capital inflow liberalization is implemented immediately ($\alpha_l = 100\%$), the outflow liberalization is pursued at a much more gradual pace ($\alpha_d = 43\%$). As in the cases with partial reforms (Cases 1 and 2), the financial reform and capital inflow liberalization both help reduce POE's funding costs and thus improves capital allocation and aggregate TFP, while subsidizing capital outflows raises the returns on household savings and alleviates intertemporal distortions. The relatively slow pace of capital outflow liberalization reflects the planner's desire to accelerate the transition to a smaller SOE sector, while mitigating the costs of investment adjustment. The full reforms lead to a welfare gain of about 31.33% in consumption equivalent units.

The magnitude of welfare gains in each of the liberalization scenario is sizable. However, the welfare gains under the full reforms (Case 3) are not much larger than those under partial reforms (Cases 1 and 2), suggesting that the bulk of the welfare gains stem from removing financial repression.

Although the relative ordering of liberalizing capital inflows and outflows may depend on the model parameters, a robust finding from our analysis is that optimal policy along the transition path calls for domestic financial reforms to be implemented at a relatively faster pace than capital account liberalization.

VIII. CONCLUSION

We have studied the implications of capital account liberalization in China under financial repression in a small open economy model with overlapping generations. We show that, unless financial repression is lifted, easing capital controls raises a tradeoff between aggregate production efficiency and intertemporal allocative efficiency.

Under financial repression, banks are required to make directed lending to low-productivity SOEs at below-market interest rates. This generates a wedge between market lending and deposit rates. Since productive private firms can borrow only at market interest rates, financial repression leads to a misallocation of resources in favor of excessive SOE production.

Easing capital inflow controls attracts additional foreign funds, reducing private firms' funding costs and enhancing aggregate TFP. However, banks respond to inflow-induced declines in market lending rates by lowering deposit rates, further distorting household consumption-savings decisions. Similarly, easing capital outflow controls improves the returns on household savings, but also pushes up domestic market lending rates, raising funding costs for private firms and reducing TFP.

Our findings provide a second-best argument for moderation in both the pace and the degree of capital account liberalization under financial repression. However, we also find that liberalizing domestic financial markets prior to opening the capital account mitigates the transition costs encountered during the capital account liberalization process. Thus, our analysis suggests that domestic financial reforms and capital account liberalization are complementary and should be pursued jointly.

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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
α	Labor income share	0.5
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
σ_m	Elasticity of substitution between SOE output and POE output	3
γ	Share of directed lending	0.5
τ_d	Tax rate on foreign asset	16.63%
τ_l	Tax rate on foreign debt	5.08%
Φ_b	Elasticity of risk premium to external debt-to-GDP ratio	3
κ_f	Desirable foreign debt-to-output ratio	0.04

TABLE 2. Alternative liberalization policies along transition paths following a decline in SOE share

	Benchmark	Inflow only	Outflow only	Full liberalization
Case	0	1	2	3
τ_d	16.63%	16.63%	-1.05%	-0.74%
α_d	-	-	46.42%	43.90%
τ_l	5.08%	-5.32%	5.08%	3.37%
α_l	-	20.68%	-	100.00%
γ	50.00%	0.82%	0.00%	0.78%
α_γ	-	100.00%	98.20%	100.00%
Welfare gains	0.00%	28.54%	31.27%	31.33%

Note: Welfare gains are expressed as in terms of consumption equivalent per period. Case 0 is the benchmark regime where all policy parameters are kept constant at its initial steady state level. In Case 1, the planner chooses the capital inflow parameters (τ_{l1} and α_l) and the financial repression parameters (γ_1 and α_γ) to maximize social welfare evaluated along the transition path (i.e., the transition welfare), holding the capital outflow parameters (τ_{d1} and α_d) constant. In Case 2, the planner keeps the inflow control parameters at their initial steady state levels and chooses the outflow control parameters and the financial repression parameters to maximize the transition welfare. In Case 3, the planner implements a full reform by choosing all policy parameters to maximize the transition welfare.

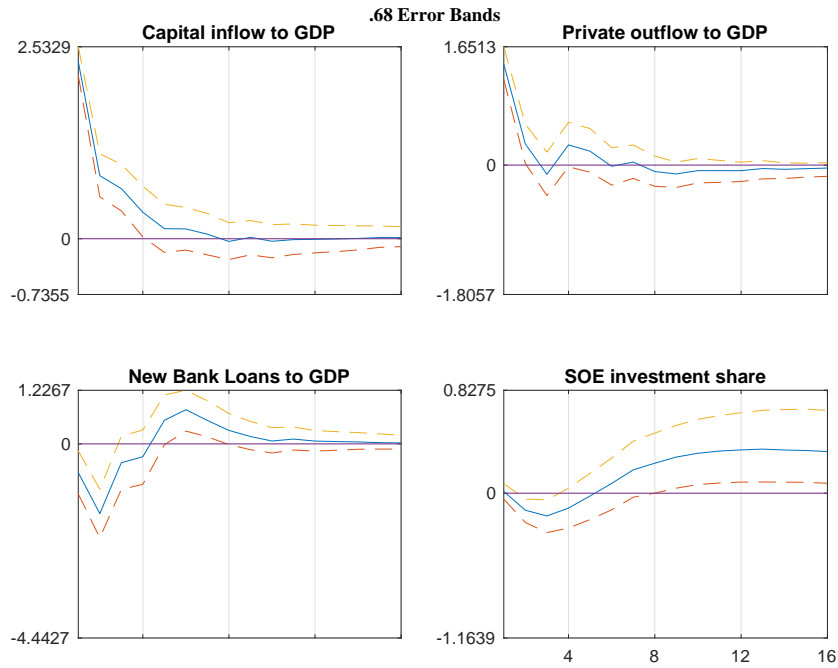


FIGURE 1. Impulse responses to a positive shock to capital inflows in an estimated BVAR model. The model includes the ratio of capital inflows to GDP, the ratio of private capital outflows to GDP, and the SOE investment share, in that order. The solid lines indicate the median impulse responses, and the dashed lines indicate the 68% probability intervals.

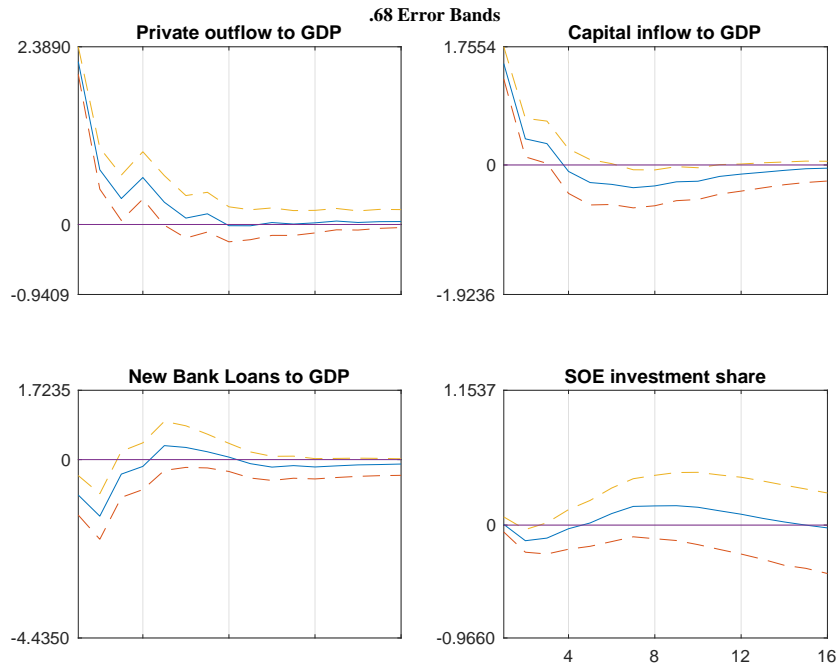


FIGURE 2. Impulse responses to a positive shock to capital outflows in an estimated BVAR model. The model includes the ratio of private capital outflows to GDP, the ratio of capital inflows to GDP, and the SOE investment share, in that order. The solid lines indicate the median impulse responses, and the dashed lines indicate the 68% probability intervals.

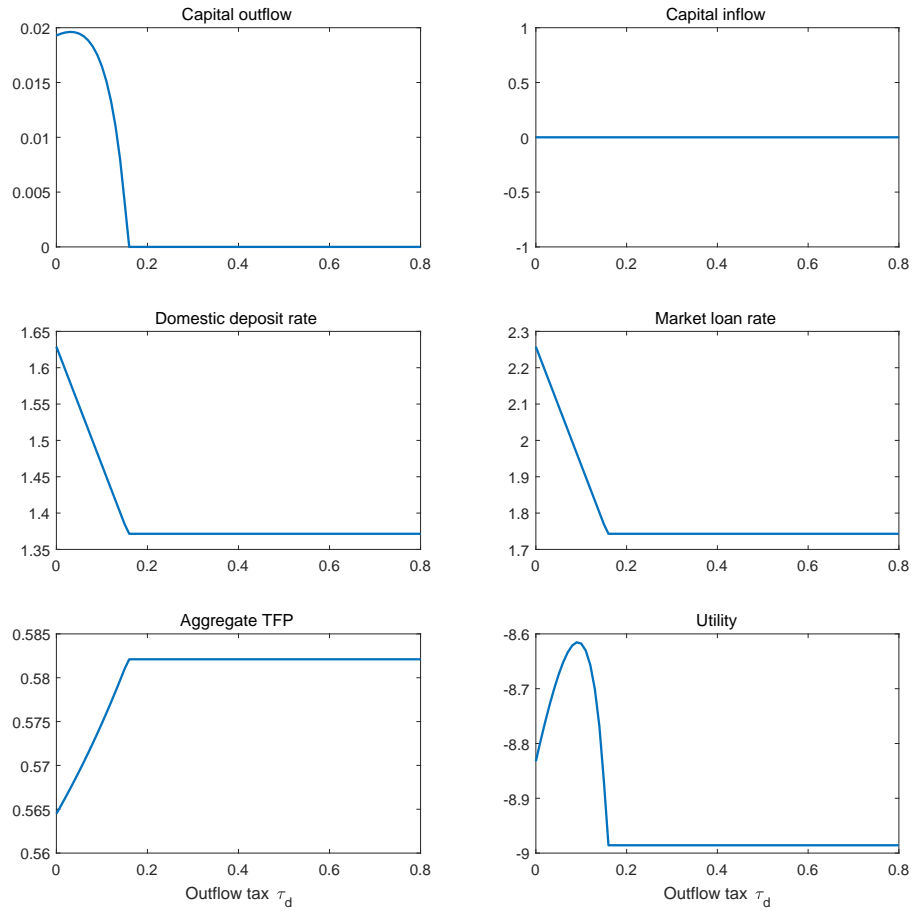


FIGURE 3. Steady-state implications of a one-way liberalization of capital outflow controls: the extreme case with no capital inflows allowed ($\tau_l = 100\%$). The horizontal axis shows the range of the capital outflow tax rate τ_d .

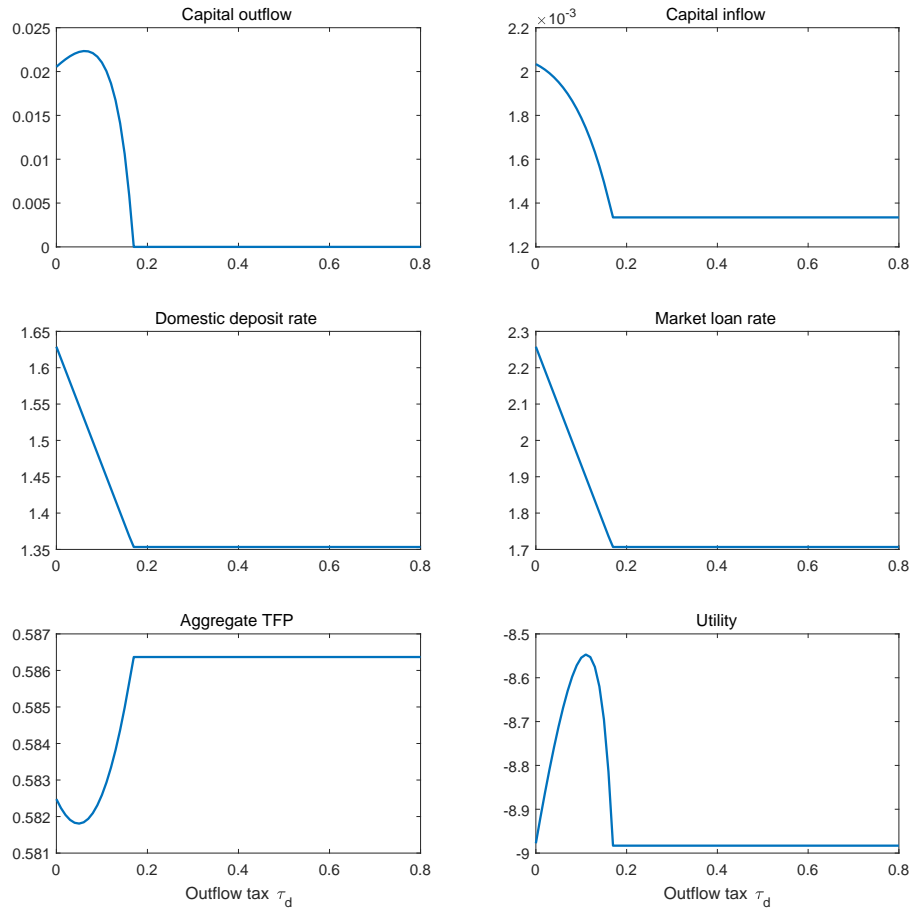


FIGURE 4. Steady-state implications of a one-way liberalization of capital outflow controls: the general case with capital inflows allowed ($\tau_l = 5.08\%$). The horizontal axis shows the range of the capital outflow tax rate τ_d .

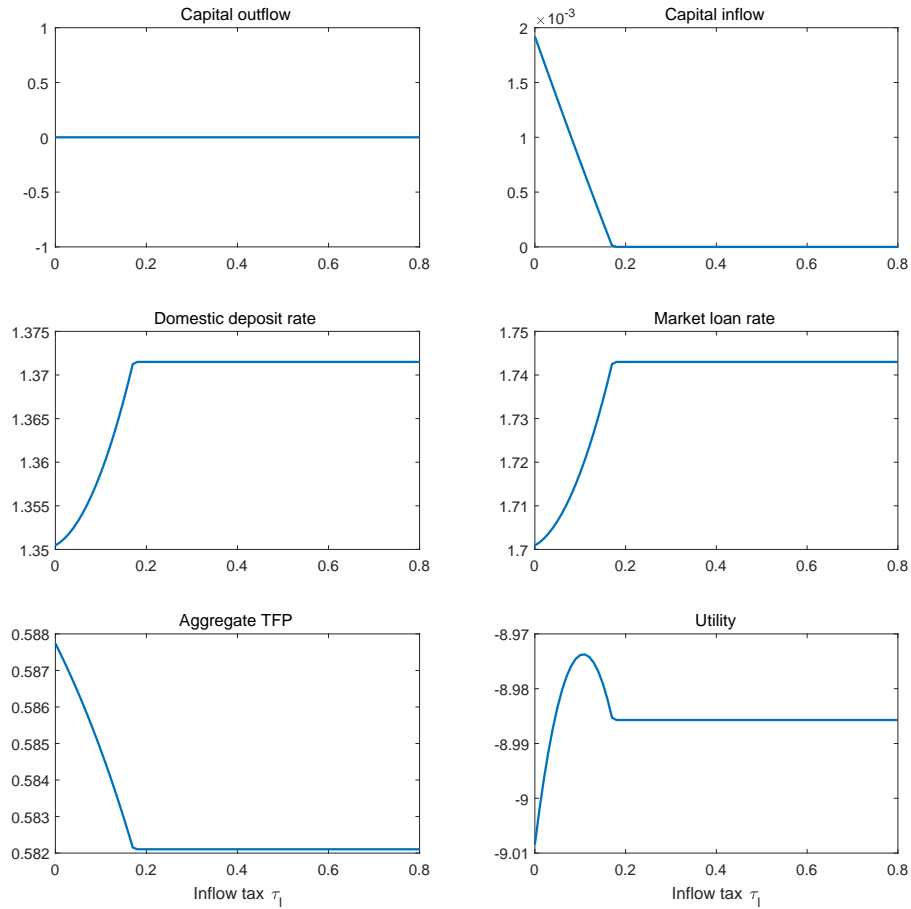


FIGURE 5. Steady-state implications of a one-way liberalization of capital inflow controls: the extreme case with no capital outflows allowed ($\tau_d = 100\%$). The horizontal axis shows the range of the capital inflow tax rate τ_l .

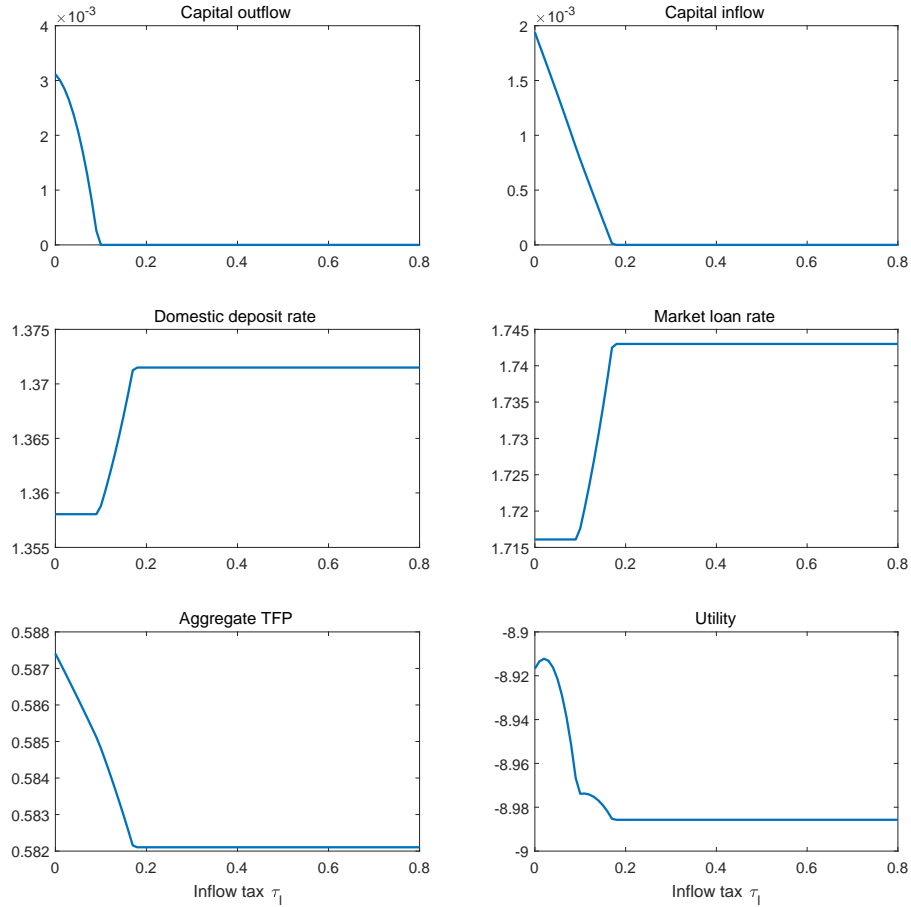


FIGURE 6. Steady-state implications of a one-way liberalization of capital inflow controls: the general case with capital outflows allowed ($\tau_d = 16.63\%$). The horizontal axis shows the range of the capital inflow tax rate τ_l .

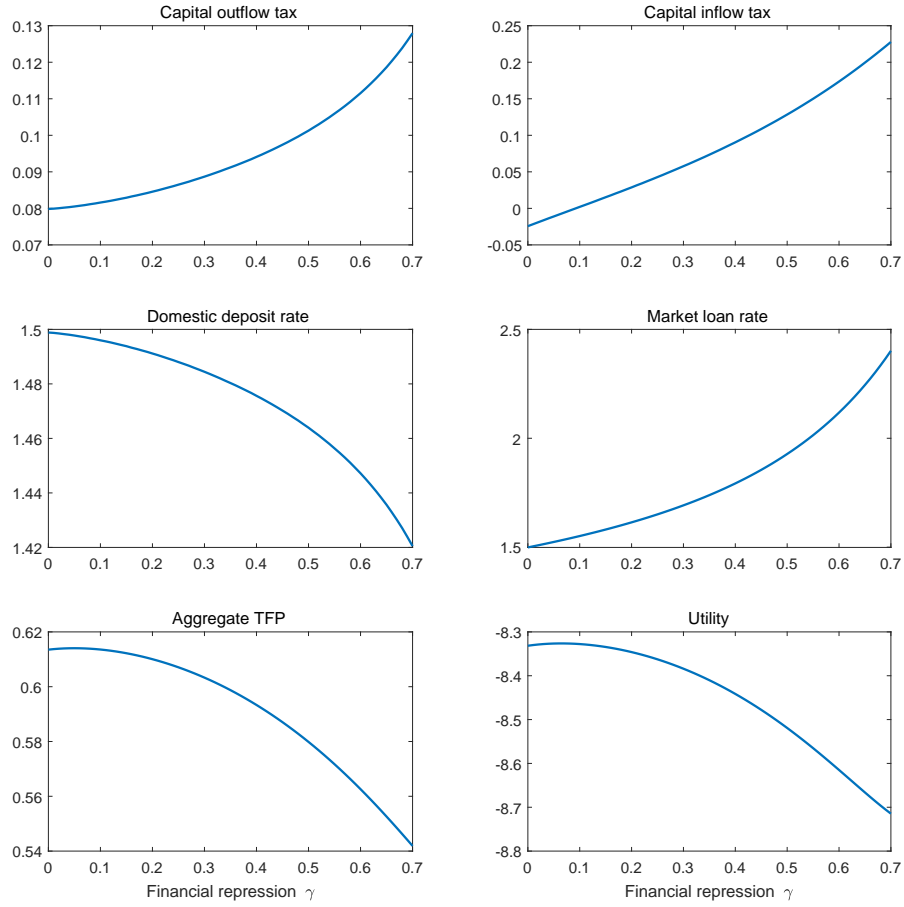


FIGURE 7. Optimal capital control policies under different degree of financial repression γ . The horizontal axis shows the range of the financial repression parameter γ .

APPENDIX A. DERIVATION OF THE EXPRESSIONS FOR R_s AND $S(\tau_d, \tau_l, \gamma)$

In what follows, we derive the expressions for the effective funding cost for SOEs (R_s) and the relative size of the SOE sector, measured by the share of capital (or labor) used by SOEs $S(\tau_d, \tau_l, \gamma)$.

We first derive the expression for R_s . In particular, we rewrite Equation (41) as follows,

$$R_s = \frac{B_g + R_l(B_s - B_g)}{B_s} = \frac{\frac{B_g}{Y} + R_l(\frac{B_s}{Y} - \frac{B_g}{Y})}{\frac{B_s}{Y}}. \quad (\text{A1})$$

where R_l is given by Eq. (40). The following expressions solve for $\frac{B_s}{Y}$ and $\frac{B_g}{Y}$ as a function of R_s :

$$\frac{B_{fl}}{Y} = b_f = \kappa_f + \frac{1}{\Phi_b} \ln\left[\frac{(1 - \tau_l)R_l}{R^*}\right], \quad (\text{A2})$$

$$\frac{B_s}{Y} = \frac{wH_s + r^k K_s p_s Y_s}{p_s Y_s} = \frac{\epsilon_s - 1}{\epsilon_s} \frac{1}{R_s} \phi, \quad (\text{A3})$$

$$\frac{B_p}{Y} = \frac{wH_p + r^k K_p p_p Y_p}{p_p Y_p} = \frac{1}{R_p} (1 - \phi) = \frac{1}{R_l} (1 - \phi), \quad (\text{A4})$$

$$\frac{D}{Y} = \frac{B_s}{Y} + \frac{B_p}{Y} - \frac{B_{fl}}{Y} = \frac{\epsilon_s - 1}{\epsilon_s} \frac{1}{R_s} + \frac{1}{R_l} (1 - \phi) - b_f, \quad (\text{A5})$$

$$\frac{B_g}{Y} = \gamma \frac{D}{Y} = \gamma \left(\frac{\epsilon_s - 1}{\epsilon_s} \frac{1}{R_s} + \frac{1}{R_l} (1 - \phi) - b_f \right). \quad (\text{A6})$$

Substituting the above equations into Eq. (A1) gives,

$$R_s = \frac{\gamma \left(\frac{\epsilon_s - 1}{\epsilon_s} \frac{1}{R_s} + \frac{1}{R_l} (1 - \phi) - b_f \right) + R_l \left[\frac{\epsilon_s - 1}{\epsilon_s} \frac{1}{R_s} \phi - \gamma \left(\frac{\epsilon_s - 1}{\epsilon_s} \frac{1}{R_s} + \frac{1}{R_l} (1 - \phi) - b_f \right) \right]}{\frac{\epsilon_s - 1}{\epsilon_s} \frac{1}{R_s} \phi}. \quad (\text{A7})$$

Note that the only unknown variable in the above equation is R_s . As a result, we can solve for R_s based on Eq. (A7), which gives:

$$R_s = \frac{\frac{\epsilon_s - 1}{\epsilon_s} \phi R}{\frac{\epsilon_s - 1}{\epsilon_s} \phi + (R_l - 1) \gamma \left(\frac{1 - \phi}{R_l} - \frac{B_{fl}}{Y} \right)}. \quad (\text{A8})$$

We now derive the expression for $S(\tau_d, \tau_l, \gamma)$. In particular, we substitute Eq. (40), Eq. (A8) and $R_p = R_l$ into Equation (39) to derive Equation (42),

$$\begin{aligned}
S(\tau_d, \tau_l, \gamma) &= \frac{K_s}{K_p} = \frac{H_s}{H_p} = \frac{R_p}{R_s} \frac{\phi}{1-\phi} \frac{1}{\mu_s} = \frac{R_l}{R_s} \frac{\phi}{1-\phi} \frac{\epsilon_s - 1}{\epsilon_s}, \\
&= \frac{\frac{\epsilon_s - 1}{\epsilon_s} \phi R_l + (R_l - 1) \gamma R_l \left(\frac{1-\phi}{R_l} - b_f \right)}{\phi R} \frac{\phi}{1-\phi}, \\
&= \left[\frac{\epsilon_s - 1}{\epsilon_s} + \frac{\frac{\epsilon_s - 1}{\epsilon_s} \phi (R_l - R) + (R_l - 1) \gamma (1 - \phi) - (R_l - 1) \gamma R_l b_f}{\phi R} \right] \frac{\phi}{1-\phi}, \\
&= \left[\frac{\epsilon_s - 1}{\epsilon_s} + \frac{\frac{\gamma(R-1)}{1-\gamma} \left(\frac{\epsilon_s - 1}{\epsilon_s} \phi + 1 - \phi \right) - \frac{R-1}{1-\gamma} R_l \gamma b_f}{\phi R} \right] \frac{\phi}{1-\phi}, \\
&= \left[\frac{\epsilon_s - 1}{\epsilon_s} + \frac{R-1}{R} \frac{\gamma}{1-\gamma} \frac{1}{\phi} \left(1 - \frac{\phi}{\epsilon_s} - R_l b_f \right) \right] \frac{\phi}{1-\phi}.
\end{aligned}$$

where b_f is the ratio of capital inflows to output, given by Eq. (38).

APPENDIX B. PROOF FOR PROPOSITION IV.1

Proof. For convenience of references, we rewrite Equation (43), which gives the first derivative of $S(\tau_d, \tau_l, \gamma)$ with respect to τ_d ,

$$\frac{\partial S}{\partial \tau_d} = -\frac{R^*}{R} \frac{\gamma}{1-\gamma} \frac{1}{1-\phi} \frac{D}{Y} + \frac{R-1}{R} \frac{\gamma}{1-\gamma} \frac{R^*}{1-\phi} \left(\frac{1}{1-\gamma} b_f + \frac{1}{\Phi_b} \frac{1}{R-\gamma} \right), \quad (\text{A9})$$

where $\frac{D}{Y} = \frac{1}{R} \left(1 - \frac{\phi}{\epsilon_s} - R_l b_f \right)$ is the deposit-to-output ratio.

We decompose $\frac{\partial S}{\partial \tau_d}$ into two parts:

$$\frac{\partial S}{\partial \tau_d} = -h_1(\tau_d) + h_2(\tau_d).$$

where

$$\begin{aligned}
h_1(\tau_d) &= \frac{R^*}{R^2} \frac{\gamma}{1-\gamma} \frac{1}{1-\phi} \left(1 - \frac{\phi}{\epsilon_s} - R_l b_f \right) > 0, \\
h_2(\tau_d) &= \frac{R-1}{R} \frac{\gamma}{1-\gamma} \frac{R^*}{1-\phi} \left(\frac{1}{1-\gamma} b_f + \frac{1}{\Phi_b} \frac{1}{R-\gamma} \right) > 0.
\end{aligned}$$

where $b_f = \kappa_f + \frac{1}{\Phi_b} \ln \left[\frac{(1-\tau_l)R_l}{R^*} \right]$ is the capital inflow to output ratio, and $R_l = \frac{(1-\tau_d)R^* - \gamma}{1-\gamma}$ is the market loan rate. The follows immediately that both b_f and R_l decreases with τ_d .

Then we have,

$$h'_1(\tau_d) = \frac{2R^{*2}}{R^3} \frac{\gamma}{1-\gamma} \frac{1}{1-\phi} \left(1 - \frac{\phi}{\epsilon_s} - R_l b_f\right) + \frac{R^{*2}}{R^2} \frac{\gamma}{1-\gamma} \frac{1}{1-\phi} \left(\frac{1}{1-\gamma} b_f + \frac{1}{1-\gamma} \frac{1}{\Phi_b}\right) > 0,$$

$$h'_2(\tau_d) = -\frac{R^{*2}}{R^2} \frac{\gamma}{1-\gamma} \frac{1}{1-\phi} \left(\frac{1}{1-\gamma} b_f + \frac{1}{1-\gamma} \frac{1}{\Phi_b}\right) - R^{*2} \frac{(R-1)^2}{R} \frac{\gamma}{(1-\gamma)^2} \frac{1}{1-\phi} \frac{1}{(R-\gamma)^2} \frac{1}{\Phi_b} < 0,$$

if $\tau_d = 1 - \frac{1}{R^*}$, then $R = 1$, $h_1(\tau_d) > 0$, and $h_2(\tau_d) = 0$,

if $\tau_d = \tau_d$ such that $1 - \frac{\phi}{\epsilon_s} - \frac{(1-\tau_d)R^* - \gamma}{1-\gamma} [\kappa_{bf} + \frac{1}{\Phi_b} \ln(\frac{(1-\tau_l)^{\frac{(1-\tau_d)R^* - \gamma}{1-\gamma}}}{R^*})] = 0$,

then $h_1(\tau_d) = 0$, and $h_2(\tau_d) > 0$.

Therefore, with the Mean-Value Theorem implies that for given values of τ_l and γ , there exists a threshold value of the capital outflow tax rate $\bar{\tau}_d \in (-\infty, 1 - \frac{1}{R^*})$, such that $h_1(\tau_d) = h_2(\tau_d)$. Furthermore,

$$\text{if } \tau_d \leq \bar{\tau}_d, \text{ then } \frac{\partial S}{\partial \tau_d} \geq -h_1(\bar{\tau}_d) + h_2(\bar{\tau}_d) = 0,$$

$$\text{if } \tau_d > \bar{\tau}_d, \text{ then } \frac{\partial S}{\partial \tau_d} < -h_1(\bar{\tau}_d) + h_2(\bar{\tau}_d) = 0.$$

□

APPENDIX C. PROOF FOR PROPOSITION IV.3

Proof. For convenience of references, we rewrite Equation (45), which gives the first derivative of $S(\tau_d, \tau_l, \gamma)$ with respect to γ , as follows,

$$\begin{aligned} \frac{\partial S}{\partial \gamma} &= (R-1) \frac{1}{1-\phi} \frac{1}{(1-\gamma)^2} \frac{D}{Y} - \frac{R-1}{R} \frac{\gamma}{1-\gamma} \frac{1}{1-\phi} \frac{R-1}{(1-\gamma)^2} \left(b_f + \frac{1}{\Phi_b}\right) \\ &= \frac{R-1}{R} \frac{1}{1-\phi} \frac{1}{(1-\gamma)^2} g(\tau_d, \tau_l, \gamma) \end{aligned} \quad (\text{A10})$$

where $\frac{D}{Y} = \frac{1}{R} \left(1 - \frac{\phi}{\epsilon_s} - R_l b_f\right)$ is the deposit-to-output ratio. $b_f = \kappa_f + \frac{1}{\Phi_b} \ln \left[\frac{(1-\tau_l)R_l}{R^*}\right]$ is the capital inflow to output ratio, and $R_l = \frac{(1-\tau_d)R^* - \gamma}{1-\gamma}$ is the market loan rate. And $g(\tau_d, \tau_l, \gamma)$ is given by,

$$\begin{aligned} g(\tau_d, \tau_l, \gamma) &= 1 - \frac{\phi}{\epsilon_s} - R_l b_f - \frac{\gamma}{1-\gamma} (R-1) \left(b_f + \frac{1}{\Phi_b}\right) \\ &= 1 - \frac{\phi}{\epsilon_s} - \frac{(1-\tau_d)R^* - \gamma}{1-\gamma} \left[\kappa_f + \frac{1}{\Phi_b} \ln\left(\frac{(1-\tau_l)^{\frac{(1-\tau_d)R^* - \gamma}{1-\gamma}}}{R^*}\right)\right] \\ &\quad - \frac{\gamma}{1-\gamma} \left((1-\tau_d)R^* - 1\right) \left(\left[\kappa_f + \frac{1}{\Phi_b} \ln\left(\frac{(1-\tau_l)^{\frac{(1-\tau_d)R^* - \gamma}{1-\gamma}}}{R^*}\right)\right] + \frac{1}{\Phi_b}\right). \end{aligned}$$

Then we have that.

$$\frac{\partial g}{\partial \gamma} = -\frac{R-1}{(1-\gamma)^2} \left(b_f + \frac{1}{\Phi_b} \right) - \frac{1}{(1-\gamma)^2} (R-1) \left(b_f + \frac{1}{\Phi_b} \right) - \frac{\gamma}{1-\gamma} \frac{1}{\Phi_b} \frac{(R-1)^2}{(R-\gamma)(1-\gamma)} < 0,$$

$$\text{if } \gamma = 0, g(\tau_d, \pi, \gamma) = 1 - \frac{\phi}{\epsilon_s} - R_l b_f = R \frac{D}{Y} > 0,$$

$$\text{if } \gamma = 1, g(\tau_d, \pi, \gamma) = -\infty.$$

Therefore, with the Mean Value Theorem, there exists $\bar{\gamma} \in (0, 1)$ such that, if $\gamma \leq \bar{\gamma}$, then $g(\tau_d, \pi, \gamma) \geq 0$ and therefore $\frac{\partial S}{\partial \gamma} \geq 0$; if $\gamma > \bar{\gamma}$, then $g(\tau_d, \pi, \gamma) < 0$ and therefore $\frac{\partial S}{\partial \gamma} < 0$.

□