Transition and capital misallocation: the Chinese case

Damien Cubizol

GATE LYON SAINT-ÉTIENNE
UMR 5824

93, chemin des Mouilles
69130 Ecully - France

Maison de l'Université, Bâtiment B
10, rue Tréfilerie
42023 Saint-Etienne cedex 02 - France

http://www.gate.cnrs.fr
gate@gate.cnrs.fr

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Keywords:
China's transition, foreign assets, FDI, consumption, global imbalances, factor market distortions

JEL codes:
E20, F21, F32, 016, P30

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†Sciences Po Toulouse, 2 Ter Rue des Puits Creuses, 31000 Toulouse. Also Univ Lyon, Université Lumière Lyon 2, GATE L-SE UMR 5824, F-69130 Ecully, France. Email: cubizol@gate.cnrs.fr

1. Introduction

There is a vast literature on the Lucas Paradox (1990), global imbalances in general, and on the role of China's capital misallocation in particular. However, most contributions do not consider the key role of public banks and State-Owned Enterprises (SOEs), while China faces a major privatization process (Figures 13 and 14) with a credit distribution that favors SOEs during the economic transition (Boyreau-Debray, 2003; Boyreau-Debray and Wei, 2005; Dollar and Wei, 2007; Héricourt and Poncet, 2009; Poncet et al., 2010; Song et al., 2011). Moreover, China experiences large FDI inflows while it accumulates foreign assets, which creates a large net external financial position (Figures 15 and 17); nevertheless, the distinction between financial flows and fixed capital flows (FDI) is crucial but rare in the literature (particularly in dynamic general growth equilibrium models).

The main contribution of this paper is to explain both the allocation puzzle of capital flows (the massive entries of FDI while foreign assets are accumulated)[1] and the drop in the consumption share in China by the misallocation of household savings to SOEs; this, in a dynamic general equilibrium model with TFP growth that differentiates FDI and financial capital flows. It identifies the main assumptions driving external and domestic imbalances among a variety of frictions. Indeed, capital expropriation, moral hazard, capital controls, and privatization are also considered here, and have an impact on capital misallocation and external surpluses. After the sensitivity analysis, the crucial element, solving the allocation puzzle of Chinese capital flows and the drop in the consumption share in this framework, is the way banks create credit distortions by driving a large share of household savings to SOEs (to the detriment of an increasing share of private firms). It leads to a rising share of labor-intensive and credit-constrained firms (private with high TFP growth) that export and accumulate profits and savings, which are invested in foreign assets[2] whereas FDI is attracted. On the other hand, the increasing share of labor-intensive and credit-constrained private firms hinders wage growth, and household deposits have low returns to finance SOEs. These elements reduce the consumption share, and therefore, they raise household savings and magnify external surpluses.[3]

Based on growth general equilibrium simulations of the transition path calibrated on the Chinese economy, the model produces a satisfactory fit with Chinese data for a variety of stylized facts over the last 30 years. Indeed, under high TFP growth (Figure 17 in Appendix C), China experienced a large current account surplus at the end of the transition

[1] The allocation puzzle of capital flows in China is the fact that despite China's high TFP growth during the transition, its net foreign assets position remained positive and large (contrary to the theory, the external financial position of China was not negative) while FDI entries were massive (Figure 15). Prasad et al. (2007) and Gourinchas and Jeanne (2013) explain well this phenomenon.

[2] Actually, external surpluses are mostly invested in foreign assets through sovereign wealth funds and the central bank, but it is not the main focus of this paper. In the model this step is skipped to maintain a simple framework.

[3] However, to keep a simple model, some determinants of household savings are not considered (for example, the bad quality of social insurance and pension system (Chamon and Prasad, 2010; Bénassy-Quéré et al., 2013; Chamon et al., 2013), demographic determinants (Modigliani and Cao, 2004; Wei and Zhang, 2011; Choukhmane et al., 2013, etc.), the rise in housing prices (Chamon and Prasad, 2010; Bussiere et al., 2013), among others). These determinants are detailed in the next section.

(up to 10 % of GDP in 2007, Figure 17 in Appendix C), whereas the U.S. had huge deficits (down to nearly 6 % of GDP in 2006). The Chinese savings rate was over 50 % in the late 2000s, resulting from an excessive savings rate for both households and firms (Figure 18 in Appendix C). Thus, foreign assets were accumulated (foreign assets over GDP increased to 50 %, Figure 15), whereas FDI massively entered into the country (Figure 15). The consumption share (as a percentage of GDP) was surprisingly decreasing throughout the transition in China (Figure 18), and private firms' investments were hindered (even if they could partly overcome this problem through shadow banking, see Tsai, 2002, Krugman, 2011, Li, 2014, and Funke et al., 2015).

This paper is close to Song et al. (2011), particularly with regard to the role of SOEs and credit constraints; thus, it sheds light on the risks of capital misallocation when financial intermediation does not completely assist firm privatization (Perotti, 1993; Kornai et al., 2003; Boyreau-Debray and Wei, 2005; Megginson, 2005; Dollar and Wei, 2007; Poncet et al., 2010; Song et al., 2011, among others). However, our theoretical framework is different; there is no OLG structure as in Song et al. (2011) but a dynamic general equilibrium model with TFP growth that distinguishes between FDI and other financial flows. Moreover, this model allows for additional assumptions (capital expropriation, moral hazard and capital controls), and above all, it explains the drop in China's consumption share. Similar to Ju and Wei (2010), the paper models two-way capital flows but in a dynamic framework that allows for richer effects. The impacts of moral hazard and the lack of property rights protection are highlighted in this model, as in the work of Ju and Wei: it raises the savings rates and the accumulation of foreign assets. However, if some assumptions of Ju and Wei (2010) are relevant and considered in the model, here, the patterns of two-way capital flows are mostly driven by the privatization of firms in China under heterogeneous credit frictions across public and private sectors. Then, the role of financial liberalization in this framework is not as important as it is in Benhima (2013) because it simply amplifies the effects of the privatization of firms under capital misallocation, but it is not at the origin of the latter. By highlighting the role of firms' structure and factor intensiveness, this work is also close to Jin (2012), in which capital flows undergo not only a convergence effect but also a composition effect. With the convergence effect in the work of Jin (2012), capital is flowing toward where it is scarce (here, inward FDI from the U.S. to China); with the composition effect, capital is flowing toward where it is intensive (here, foreign reserves from China to the U.S.) after a labor force/productivity shock (here, in China). Similar to our paper, Wang (2016) distinguishes between private and public sectors in China by emphasizing that the private sector is taxed, with a repressed wage growth that supports GDP growth, and that capital markets distortions favor SOEs. Finally, our study also adds to the existing literature[3] on the decrease in the consumption share in China, which is described in the next section. In our theoretical framework, the drop in the consumption share is mainly explained by low returns on SOE bonds held by

households and by the rising share of labor-intensive firms in which credit constraints hinder wage growth.

After a literature review in Section 2, the model is analyzed in the next section. The calibration is explained in Section 4, while Section 5 describes the results and the sensitivity of the model to the different frictions and explanatory factors.

2. Literature review

One major contribution of this paper is the explanation of a large part of the drop in the consumption share by the misallocation of household savings to SOEs. The induced increasing share of credit-constrained private firms hinders wage growth, and a large part of household deposits have low returns to finance SOEs. These explanations add to the existing literature explaining the high household saving rate. Indeed, a large part of the literature states that an improvement in the quality of social insurance and pension system would significantly reduce household savings (Chamon and Prasad, 2010; Bénassy-Quéré et al., 2013; Chamon et al., 2013). Then, two other points are crucial: the rise in housing prices (Chamon and Prasad, 2010; Bussiere et al., 2013, among others) and the one-child policy. Indeed, concerning the latter, Wei and Zhang (2011) shed light on a strong empirical evidence of a link between the unbalanced sex ratio (due to the one-child policy of the government) and the recent and strong rise of the saving rate.[4] The one-child policy also impacts household saving rate through another channel: education expenditures and the magnitude and the direction of intergenerational transfers (Choukhmane et al., 2013). Indeed, culturally, children help their parents during their retirement, so these transfers can become a real burden for one-child families in China. Credit constraints for households are also an explanation of the high saving rate (Bussiere et al., 2013; Coeurdacier et al., 2015), as well as age-income profiles (Song and Yang, 2010), income uncertainty (Chamon et al., 2013), and structural demographic trends (Modigliani and Cao, 2004; Ge and Yang, 2011; Curtis et al., 2015).

The second main contribution of this paper is to reproduce the specific patterns of capital flows in China, that is, a massive entry of FDI and an accumulation of foreign assets. The entries of FDI when there is a high TFP growth are in line with the neoclassical models, however, these inward FDI should be followed by the entry of financial capital

[4]Knowing that, culturally, Chinese families prefer to have a son than a daughter, the one-child policy has resulted in an unbalanced sex ratio. Then, the competition in the marriage market has become more intense, so the saving rate of households that have a boy has increased (Wei and Zhang, 2011). The authors highlight that the consequences of this increasing competition in the marriage market, for example leading to the rise in housing prices, also contributes to increase the saving rate of other households. Finally, according to Wei and Zhang (2011), both cross-regional and household-level evidences support this hypothesis, and the elements related to the one-child policy and sex ratios can potentially account for about half the actual increase in the household saving rate during 1990-2007.

(that is, a negative net external financial position). Thus, the large accumulation of foreign assets by the Chinese economy is linked to the Lucas Paradox (1990) and the allocation puzzle of capital flows of Gourinchas and Jeanne (2013). Indeed, Lucas (1990) emphasizes that the volume of capital flows to developing countries is abnormally small compared to the theory. According to the latter, a developing country should be indebted to developed countries to finance its high TFP growth and accumulation of fixed capital. Regarding the allocation puzzle of Gourinchas and Jeanne (2013), it concerns the allocation of capital inflows across developing countries and how this allocation is correlated with cross-country differences in productivity growth, which is also not consistent with the theory. The Lucas Paradox (1990) and the allocation puzzle of Gourinchas and Jeanne (2013) are well explained in Prasad et al. (2007).

The accumulation of foreign assets by the Chinese economy and the large current account surplus at the end of the transition are key elements of the recent literature on global imbalances (that is, the presence of external surpluses, particularly in emerging Asia, and strong current account deficits in the U.S. and other developed countries). A main explanation emerges from the debate surrounding international global imbalances. High growth in emerging countries and structural imperfections, such as deficient institutions, governance, credit markets, or social insurance, and specific demographic trends, lead to high savings (respectively, investment) rates in emerging (respectively, developed) countries (Blanchard and Milesi-Ferretti, 2009). Given the low level of financial development and the lack of safe assets in emerging countries, savings flow toward developed countries with riskless financial markets (Caballero et al., 2008; Mendoza et al., 2009; Ju and Wei, 2010 and 2014). It is the "global saving glut" of Bernanke (2005), which was empirically studied by Forbes (2010). A relevant point is that, in the literature, the "global saving glut" and global imbalances involve aggregate net foreign assets (both public and private). However, in the empirical work of Alfaro et al. (2014), sovereign-to-sovereign transactions can fully account for net capital outflows from emerging countries and global imbalances. It is in line with the work of Aguiar and Amador (2011), in which a variant of the open economy neoclassical growth model (that emphasizes political economy and contracting frictions) explains that the net foreign asset position in fast growing open economies is driven by the public sector.

3. Model

A model of two large countries labeled d (domestic) and f (foreign) is built, with infinite horizon. To fit our issue and context, the domestic country is China and the foreign country is the U.S. Each country has households and firms. Households work, consume and save; their savings finance investments of domestic and foreign firms (the

first part of foreign assets).[5] Firms accumulate capital and use a share of their capital to produce abroad, which is assimilated to FDI. Firms are credit-constrained and produce utilizing a standard Cobb-Douglas technology. TFP growth is considered to model growth differentials between the U.S. and China. In China, SOEs are added to private domestic and foreign firms. They are less productive[6] but have better access to credit (credit constraints for SOEs are relaxed, making them capital-intensive whereas private firms remain labor-intensive, as in Song et al., 2011).

An economic liberalization (privatization of firms) in China is set through an exogenous decreasing share of employment in SOEs. In addition, financial frictions of two types are considered. First, a ratio of defaulting loans (moral hazard) reduces returns on bonds and loans repayments. Second, restrictions to capital flows are modeled in the form of trade costs on the purchase of foreign bonds. Firms' savings are impacted by the previous elements but also by a capital expropriation rate (corruption and lack of property rights protection), which is not redistributed and is modeled as a potentially higher depreciation rate of capital. The magnitude of all these frictions slightly varies between SOEs, domestic and foreign private firms, creating the capital misallocation. A key assumption (which is also relaxed in the results analysis) makes private firms accumulate savings with export profits; then, financial intermediaries invest these savings abroad (the second part of foreign assets).[7] Finally, the model is focused on real factors and abstracts from nominal rigidities to keep the framework simple, so relative prices are assumed to be one. The nominal exchange rate cannot be considered without prices of goods, nominal rigidities, or value function for bonds prices. As for the real exchange rate, the relative marginal costs give an idea of its evolution.[8] This set of frictions and assumptions under privatization affects savings and investments, so financial capital flows, FDI and consumption. The model demonstrates that a realistic calibration exercise solves the allocation puzzle of capital flows[9] and the drop in the consumption share in China, and produces a satisfactory fit with Chinese data for the stylized facts described in the introduction.

[5] Actually, Chinese savings are invested in foreign bonds through the central bank and sovereign wealth funds, but it is not the main focus here. This step is skipped in the model to maintain a simple framework and it is assumed that household and corporate savings directly finance foreign firms (and of course domestic ones), as in Benhima (2013) for example.

[6] According to Hsieh and Song (2015), large and old Chinese SOEs have a lower TFP level compared to private firms, but recently their TFP growth would be higher (particularly, labor productivity). In our paper, the focus is the transition since the 1980s, so TFP growth in SOEs is assumed to be lower than in private firms (Brandt and Zhu, 2010); thus, SOEs can have financial losses, which is true for a share of the population of SOEs (Aglietta and Landry, 2007; Zhou, 2013; Borst and Lardy, 2015).

[7] As described in the subsection on firms, this assumption is realistic because according to Huang (2011), private firms in China have a precautionary motive and accumulate savings. These savings are then invested in foreign assets to overcome the low domestic financial development (Caballero et al., 2008; Benhima, 2013). It is equivalent to consider that the government uses the profits of firms that export a lot (the more productive and labor-intensive private firms) to buy foreign bonds, which is indirectly equivalent to the accumulation of foreign reserves by the central bank (indirectly, because the monetary aspect and the use of sovereign wealth funds is skipped for simplicity in this framework). Note that the results are also described when this assumption is relaxed (Subsubsection 5.1.1).

[8] See the results section for the approximation of the real exchange rate.

[9] The allocation puzzle of capital flows in China is the fact that despite China's high TFP growth during the transition, its net foreign assets position remained positive and large (contrary to the theory, the external financial position of China was not negative) while FDI entries were massive (Figure 15). Prasad et al. (2007) and Gourinchas and Jeanne (2013) explain well this phenomenon.

3.1. Households

Domestic households maximize a welfare index:

$$\begin{cases} MaxE_0 \sum_{t=0}^{\infty} \beta_d^t \left(\frac{C_{d,t}^{1-\sigma}}{1-\sigma} - \frac{N_{S,t}^{1+\psi}+N_{d,t}^{1+\psi}+N_{f,t}^{*1+\psi}}{1+\psi} \right) & \sigma \neq 1, \\ MaxE_0 \sum_{t=0}^{\infty} \beta_d^t \left(\log(C_{d,t}) - \frac{N_{S,t}^{1+\psi}+N_{d,t}^{1+\psi}+N_{f,t}^{*1+\psi}}{1+\psi} \right) & \sigma = 1. \end{cases}$$

subject to the budget constraint:

$$\begin{aligned} C_{d,t} + B_{d,t} + B_{S,t} + \left[B_{d,t}^* + \frac{\chi_d}{1+\mu_d} \left(B_{d,t}^* - B_{d,t-1}^* \right)^{1+\mu_d} \right] = (1 + r_{f,t}) (1 - \gamma_f) B_{d,t-1}^* \\ + (1 + r_{d,t}) \left[(1 - \gamma_S) B_{S,t-1} + (1 - \gamma_d) B_{d,t-1} \right] + W_{d,t} N_{d,t} + W_{S,t} N_{S,t} + W_{f,t}^* N_{f,t}^* \end{aligned} \quad (1)$$

β is the discount rate, ψ the inverse of the Frisch elasticity of labor supply, and σ the inverse of the intertemporal elasticity of substitution. $N_{d,t}$ (resp. $N_{f,t}^*$) represents hours of work supplied by domestic households in the domestic firms (resp. foreign expatriated firms), $N_{S,t}$ labor supply in SOEs, and $C_{d,t}$ consumption.

Household incomes ($W_{d,t}N_{d,t}$ from domestic firm, $W_{f,t}^*N_{f,t}^*$ from foreign expatriated firms, and $W_{S,t}N_{S,t}$ from SOEs) are partly consumed in a single good and saved utilizing bonds. Households hold bonds issued by firms of country d ($B_{d,t}$ for private firms, $B_{S,t}$ for SOEs, determined by Equations 16 and 17 in the subsection on firms) and foreign bonds ($B_{d,t}^*$) with incomplete financial markets. Various degrees of financial integration can be considered with varying trading costs on the purchase of foreign bonds $\frac{\chi_d}{1+\mu} \left(B_{d,t}^* - B_{d,t-1}^* \right)^{1+\mu}$; these costs are a proxy for capital controls. Parameter χ_d controls for the magnitude of costs and μ for their curvature.[10] Firms are credit-constrained and borrow utilizing household savings. In Equation (1), $r_{d/f,t}$ are domestic and foreign real interest rates, and an exogenous ratio γ of defaulting loans reduces loans repayments by firms and returns on households' bonds. It captures firms' moral hazard.

[10] Chinese financial integration is more complex. Indeed, there are different limited amounts and taxes depending on the direction and type of financial flows, and it was varying during the transition (Kimball and Xiao, 2006, and the *Annual Report of Exchange Arrangements and Exchange Restrictions* (AREAER)). Note that trading costs are based on new bonds purchases at time t and not on the divergence from the steady state. Indeed, deterministic simulations are conducted and reforms change the steady state. With stochastic shocks, trading costs should be: $\frac{\chi_d}{1+\mu} \left(B_{d,t}^* - \overline{B_d^*} \right)^{1+\mu}$.

First ordinary conditions are:

$$N_{d,t} = \left[W_{d,t}C_{d,t}^{-\sigma}\right]^{\frac{1}{\psi}} \quad (2)$$

$$N_{f,t}^{*} = \left[W_{f,t}^{*}C_{d,t}^{-\sigma}\right]^{\frac{1}{\psi}} \quad (3)$$

$$N_{S,t} = \left[W_{S,t}C_{S,t}^{-\sigma}\right]^{\frac{1}{\psi}} \quad (4)$$

$$C_{d,t}^{-\sigma} = \beta E_t\left[C_{d,t+1}^{-\sigma}\left(1+r_{d,t+1}\right)\left(1-\gamma_d\right)\right] \quad (5)$$

$$\lambda_{d,t}\left[1+\chi_d\left(B_{d,t}^{*}-B_{d,t-1}^{*}\right)^{\mu_d}\right] = \beta E_t\left[\lambda_{d,t+1}\left(1+r_{f,t+1}\right)\left(1-\gamma_f\right)\right] \quad (6)$$

Equations (2), (3) and (4) are the labor supplies of households to firms, and Equation 5 is the usual Euler equation. Although there are important frictions on the Chinese labor market, for simplicity the latter is modeled as competitive and frictionless because such frictions would only change the speed and magnitude of reallocation and the evolution of wages, but not the qualitative behavior of all variables.[11] The Lagrangian multiplier $\lambda_{d,t}$ captures the marginal utility of consumption ($\lambda_{d,t} = C_{d,t}^{-\sigma}$). By combining Equations (5) and (6), the trade-off between domestic and foreign bonds ($B_{d,t}^{*}$) is obtained, once the amount of domestic bonds is fixed through firms' credit constraints (more details are in the subsection on firms).

$$E_t\left[\lambda_{d,t+1}\left[\frac{\left(1+r_{d,t+1}\right)\left(1-\gamma_d\right)\left(1+\chi_d\left(B_{d,t}^{*}-B_{d,t-1}^{*}\right)^{\mu_d}\right)}{\left(1+r_{f,t+1}\right)\left(1-\gamma_f\right)}-1\right]\right]=0 \quad (7)$$

China buys foreign bonds $B_{d,t}^{*}$ (resp. becomes indebted to the U.S.) when returns on foreign bonds are higher (resp. lower) than those on domestic bonds:

$$\left(1+r_{f,t+1}\right)\left(1-\gamma_f\right) > \left(1+r_{d,t+1}\right)\left(1-\gamma_d\right)\left[1+\chi_d\left(B_{d,t}^{*}-B_{d,t-1}^{*}\right)^{\mu_d}\right].$$

Foreign households solve the same problem but they do not buy foreign bonds ($B_{f,t}^{*}=0$). Indeed, foreign liabilities in China were negligible during the last two decades (up to 4% of GDP) compared to foreign assets (approximately 50%).[12]

The list of all variables is in Table 1.

[11] Zuo and Wang (1999) explain that despite the huge flows of rural migrants to cities that followed reforms during the transition, the access of rural migrants to urban labor markets is selective (*Hukou* system). Even if these restrictions on migrations were still present in the second part of the transition, they were considerably reduced (Wang, 2004).

[12] Source: IMF database.

3.2. Firms

The domestic country (China) has a population of firms comprising private domestic firms, private foreign firms and SOEs. The foreign country (here, the U.S.) only has private domestic and foreign firms.

Domestic firms accumulate capital, produce, and maximize their stream of profits:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \lambda_{d,t} \pi_{d,T,t} \tag{8}$$

with

$$\begin{aligned} \pi_{d,T,t} = \pi_{d,t} + \pi^*_{d,t} + \pi_{S,t} = Y_{d,t} + Y^*_{d,t} + Y_{S,t} + D_{d,t} - (1 + r_{d,t})(1 - \gamma_d) D_{d,t-1} \\ + D^*_{d,t} - (1 + r_{f,t})(1 - \gamma_f) D^*_{d,t-1} + D_{S,t} - (1 + r_{d,t})(1 - \gamma_S) D_{S,t-1} \\ - (W_{d,t} N_{d,t} + I_{d,t}) - \left(W^*_{d,t} N^*_{d,t} + I^*_{d,t}\right) - (W_{S,t} N_{S,t} + I_{S,t}) \end{aligned} \tag{9}$$

Firms operate in both countries because a share of their capital is expatriated to produce abroad: it is equivalent to investing in the foreign country through FDI. $\pi_{d,T,t}$ represents the total profits of domestic firms, $\pi_{d,t}$ (resp. $\pi^*_{d,t}$) the profits of the capital invested locally (resp. abroad) by private domestic firms, and $\pi_{S,t}$ the profits of SOEs.
When expatriated, firms have their *home* country's initial level of TFP and share of capital in production, but the TFP growth, labor force, capital depreciation and funding are from the *host* (that is, *local*) country. Indeed, according to Du and Girma (2007), foreign firms in China were equally financed by the home and host countries' financial intermediation during the transition.[13]

Production and technology. Production combines labor and capital through Cobb-Douglas technology:

$$Y_{d,t} = A_{d,t}.K^{\alpha_d}_{d,t-1} N^{1-\alpha_d}_{d,t} \tag{10}$$

$$Y^*_{d,t} = A_{d^*,t}.K^{\alpha_d}_{d^*,t-1} N^{1-\alpha_d}_{d^*,t} \tag{11}$$

$$Y_{S,t} = A_{S,t}.K^{\alpha_S}_{S,t-1} N^{1-\alpha_S}_{S,t} \tag{12}$$

where $Y_{d,t}$ is the production of a domestic firm locally, $Y^*_{d,t}$ the production of a domestic firm abroad, and $Y_{S,t}$ the production of SOEs. The technology parameter A_t grows at an exogenous rate g_A: $A_t = (1 + g_A)A_{t-1} = (1 + g_A)^t A_0$. $g_{A_d} > g_{A_f}$ to have a larger TFP growth in China than in the U.S. TFP growth and the initial level of TFP are not

[13] Feldstein (2000), Harrison and McMillan (2003), and Alfaro et al. (2009) also mention the role of the local credit market on FDI determinants.

similar across firms in China: domestic private firms have a higher initial level of TFP than SOEs ($A_{d,0} > A_{S,0}$) and a higher TFP growth ($g_{A_d} > g_{A_S}$).[6] As described above, the initial level of technology of expatriated firms is from the home country; thus, foreign private firms in China have a higher initial technology level than domestic firms ($A_{f^*,0} > A_{d,0}$) but have the same TFP growth.

Balanced growth. The model is solved along the balanced growth path to have stationarity: except interest rates and hours worked, each variable is computed against A_t to deflate by the state of technology.[14] All the equations solved along the balanced growth path are presented in Appendix A.

Investment. The accumulation of capital in domestic firms d, d^* and S has the following law of motion:

$$K_{d,t} = (1-\delta_d) K_{d,t-1} + I_{d,t} \tag{13}$$

$$K^*_{d,t} = (1-\delta_f) K^*_{d,t-1} + I^*_{d,t} \tag{14}$$

$$K_{S,t} = (1-\delta_S) K_{S,t-1} + I_{S,t} \tag{15}$$

where $K^*_{d,t}$ and $I^*_{d,t}$ are domestic capital and investment expatriated in the foreign country to produce $Y^*_{d,t}$. Capital depreciates at each period at a rate δ (δ_d for private domestic capital, δ_f for private expatriated capital and δ_S for SOEs).[15] Capital expropriation is modeled as a much higher and constant depreciation rate. This higher depreciation captures corruption in China (Angang, 2001 and 2002), but note that in the model, there is no redistribution of this expropriated capital: it is a fraction of capital at time $t-1$ which "disappears" at time t. There is a heterogeneous calibration of parameter δ between private firms and SOEs as detailed in Subsection 4.3.

Debt and credit constraints. Firms can borrow additional capital. The total amount of deposits available in banks to lend to firms is the addition of household domestic savings (the purchase of domestic bonds, $B_{d,t}$ and $B_{S,t}$) and the purchase of bonds by the foreign country: $D_{d,T,t} = B_{d,t} + B_{S,t} + B^*_{f,t}$ in China, $D_{f,T,t} = B_{f,t} + B^*_{d,t}$ in the U.S. $B_{d,t}$ comprises bonds of private domestic and foreign firms, $B_{S,t}$ are bonds of SOEs.[16] The amount of purchases of foreign bonds is determined by Equation (7) in China (equal to 0 in the U.S.), and the amount of domestic bonds is

[14] For example, $Y^*_{d,t}$ and the dynamic of expatriated capital become $y^*_{d,t} = \frac{Y^*_{d,t}}{A^*_{d,t}}$ and $k^*_{d,t} = (1-\delta_f)\frac{K^*_{d,t-1}}{A^*_{d,t-1}}.\frac{A^*_{d,t-1}}{A^*_{d,t}} + \frac{I^*_{d,t}}{A^*_{d,t}} = (1-\delta_f)\frac{k^*_{d,t-1}}{1+g_{A_f}} + i^*_{d,t}$, with $A^*_{d,t} = (1+g_{A_f})^t A_{d,0}$ for expatriated firms. See the details in Appendix A.

[15] Along the balanced growth path, the accumulation of capital becomes (for the three types of firms d, d^* and S):

$$k_{d,d^*,S_t} = (1-\delta_{d,f,S})\frac{k_{d,d^*,S_{t-1}}}{1+g_{A_{d,f,S}}} + i_{d,d^*,S_t}$$

.

[16] Then, for private firms, the deposits from the purchases of domestic bonds $B_{d,t}$ by households are proportionally distributed between domestic and foreign firms according to their capital size (see Appendix A).

determined with *borrowing constraints* ζ faced by firms:

$$B_{d,t} = \zeta_d \left(K_{d,t} + K^*_{f,t}\right) \tag{16}$$

$$B_{S,t} = \zeta_S K_{S,t} \tag{17}$$

$\zeta_S > \zeta_d$ because there are tighter credit constraints for private firms than for SOEs (Boyreau-Debray, 2003; Boyreau-Debray and Wei, 2005; Dollar and Wei, 2007; Héricourt and Poncet, 2009; Poncet et al., 2010; Song et al., 2011). To bypass these credit constraints, some private firms use FDI (Héricourt and Poncet, 2009; Ju and Wei, 2010; Poncet et al., 2010) or shadow banking (Tsai, 2002; Krugman, 2011; Li, 2014; Funke et al., 2015). These are not modeled here to maintain a simple framework. As explained above, firms' domestic branches borrow in the country of origin, whereas their expatriated branches borrow abroad (Du and Girma, 2007).

First order conditions imply:

$$(1-\alpha_d)\frac{Y_{d,t}}{N_{d,t}} = W_{d,t} \tag{18}$$

$$(1-\alpha_d)\frac{Y^*_{d,t}}{N^*_{d,t}} = W^*_{d,t} \tag{19}$$

$$(1-\alpha_S)\frac{Y_{S,t}}{N_{S,t}} = W_{S,t} \tag{20}$$

$$E_t\left[\frac{\lambda_{d,t+1}}{\lambda_{d,t}}\left(1-\delta_d+\alpha_d\frac{Y_{d,t+1}}{K_{d,t}}-\zeta_d\left(1+r_{d,t}\right)\left(1-\gamma_d\right)\right)-\left(\frac{1-\zeta_d}{\beta}\right)\right] = 0 \tag{21}$$

$$E_t\left[\frac{\lambda_{d,t+1}}{\lambda_{d,t}}\left(1-\delta_f+\alpha_d\frac{Y^*_{d,t+1}}{K^*_{d,t}}-\zeta_f\left(1+r_{f,t}\right)\left(1-\gamma_f\right)\right)-\left(\frac{1-\zeta_f}{\beta}\right)\right] = 0 \tag{22}$$

$$E_t\left[\frac{\lambda_{d,t+1}}{\lambda_{d,t}}\left(1-\delta_S+\alpha_S\frac{Y_{S,t+1}}{K_{S,t}}-\zeta_S\left(1+r_{d,t}\right)\left(1-\gamma_S\right)\right)-\left(\frac{1-\zeta_S}{\beta}\right)\right] = 0 \tag{23}$$

Equations (18), (19) and (20) are standard labor demands, and Equations (21), (22) and (23) capture the marginal returns on investment. Firms have the choice to invest in either the domestic country or the foreign country; thus, the share of capital invested abroad depends on the marginal product of capital compared to credit costs. The former depends on the initial technology, TFP growth, the capital and labor shares, and capital depreciation, whereas credit costs depend on the real interest rate, the tightness of credit constraints and moral hazard. A firm makes the choice to invest

fixed capital abroad when $1-\delta_f+\alpha_d\frac{Y^*_{d,t+1}}{K^*_{d,t}}-\zeta_f\left(1+r_{f,t}\right)\left(1-\gamma_f\right)$ is larger than $1-\delta_d+\alpha_d\frac{Y_{d,t+1}}{K_{d,t}}-\zeta_d\left(1+r_{d,t}\right)\left(1-\gamma_d\right)$.[17]

Firms' savings. A crucial assumption is that domestic firms accumulate profits, which are saved to buy foreign *financial assets* (bonds). This assumption is realistic because according to Huang (2011), private firms in China have a precautionary motive and accumulate savings. These savings are then indirectly invested in foreign assets to overcome the low domestic financial development (Caballero et al., 2008; Benhima, 2013).[18] It is equivalent to consider that the government uses the profits of firms that export a lot (the more productive and labor-intensive private firms) to buy foreign bonds, which is *indirectly* equivalent to the accumulation of foreign reserves by the central bank (indirectly, because the monetary aspect and the use of sovereign wealth funds is skipped for simplicity in this framework). These *indirect* holdings of foreign assets by private firms are mentioned in Benhima (2013, p. 325), who also highlights the parallel trend of bank deposits and reserves (China Statistical Yearbook and Song et al., 2011). Our assumption is valid only for private firms, not for SOEs. Indeed, SOEs' savings (which are lower than those of private firms, see Huang, 2011) are mostly re-invested in production, invested abroad through outward FDI (Morck et al., 2008; Ramasamy et al., 2012), or re-distributed to bureaucrats without paying dividends (Morck et al., 2008). Thus, under this assumption, private firms' savings (profits) are added to variable $B^*_{d,t}$ (the purchase of foreign bonds with household savings) to define China's foreign assets position in the model: $FA_{d,t}=B^*_{d,t}+\pi_{d,t}+\pi_{f^*,t}$. The consequences of the relaxation of this assumption on the results are discussed at the end of Subsubsection 5.1.1. Another implication of this assumption is that firms' profits at time $t-1$ (and the induced returns on savings) are not computed in the firms' optimization program at time t. These profits are saved in foreign assets, and incomes at time t are added to incomes at time $t-1$. Thus, incomes on private firms' savings in China are:

$$\begin{aligned} IC_{d+f^*,t} &= r_{f,t-1}\left(1-\gamma_f\right)\left[\pi_{d,t-1}+\pi_{f^*,t-1}-\tfrac{\chi_d}{1+\mu_d}\left[\left(\pi_{d,t}-\pi_{d,t-1}\right)^{1+\mu_d}+\left(\pi_{f^*,t}-\pi_{f^*,t-1}\right)^{1+\mu_d}\right]\right] \\ &\quad +IC_{d+f^*,t-1} \end{aligned} \tag{27}$$

$\frac{\chi_d}{1+\mu_d}\left(\pi_t-\pi_{t-1}\right)^{1+\mu_d}$ are trading costs (capital controls, which are also set for household savings invested in foreign bonds).

[17] Along the balanced growth path, marginal returns on investments are:

$$mR_{I_{d,t}} = \left[\alpha_d\frac{y_{d,t+1}}{k_{d,t}}\left(1+g_{A_d}\right)+\left(1-\delta_d-\zeta_d\left(1+r_{d,t}\right)\left(1-\gamma_d\right)\right)\right]-\left(\frac{1-\zeta_d}{\beta}\right) \tag{24}$$

$$mR_{I_{d^*,t}} = \left[\alpha_d\frac{y^*_{d,t+1}}{k^*_{d,t}}\left(1+g_{A_f}\right)+\left(1-\delta_f-\zeta_f\left(1+r_{f,t}\right)\left(1-\gamma_f\right)\right)\right]-\left(\frac{1-\zeta_f}{\beta}\right) \tag{25}$$

$$mR_{I_{S,t}} = \left[\alpha_S\frac{y_{S,t+1}}{k_{S,t}}\left(1+g_{A_S}\right)+\left(1-\delta_S-\zeta_S\left(1+r_{d,t}\right)\left(1-\gamma_S\right)\right)\right]-\left(\frac{1-\zeta_S}{\beta}\right) \tag{26}$$

[18] Note that in the model, firms located in the U.S. accumulate savings but do not buy foreign assets. Indeed, U.S. firms experienced a large cash-to-assets ratio from 1980 to 2006 (see Bates et al., 2009).

Foreign firms solve the same problem with similar equations for their domestic and expatriated private firms but without SOEs. Under the following calibration, $FA_{d,t} > 0$: there are foreign bonds purchases by China (with household savings $B^*_{d,t}$, in Equation (7), and with corporate savings $\pi_{d,t} + \pi_{f^*,t}$ above); thus, firms in the foreign country are indebted to China. It is equivalent to the external financial deficit of the U.S. Note that Equations (19) and (22) are valid for domestic firms operating abroad. The foreign firms operating in China have the following labor demand and marginal returns on investments:

$$(1-\alpha_f)\frac{Y^*_{f,t}}{N^*_{f,t}} = W^*_{f,t} \tag{28}$$

$$E_t\left[\frac{\lambda_{f,t+1}}{\lambda_{f,t}}\left(1-\delta_d+\alpha_f\frac{Y^*_{f,t+1}}{K^*_{f,t}}-\zeta_d\left(1+r_{d,t}\right)\left(1-\gamma_d\right)\right)-\left(\frac{1-\zeta_d}{\beta}\right)\right] = 0 \tag{29}$$

with $Y^*_{f,t} = A_{f^*,t}.K^{\alpha_f}_{f^*,t-1}N^{1-\alpha_f}_{f^*,t}$ and $A_{f^*,t} = (1+g_{A_d})^t A_{f,0}$. As explained at the beginning of Subsection 3.2, their capital share and initial level of technology remain from the home country while their funding, TFP growth, labor force and capital depreciation are local.

The list of all variables is in Table 1.

3.3. Aggregation

Labor market clearing conditions are straightforward (already implicitly imbedded in the households section): the aggregate labor supply in the domestic country is $(N_{d,t} + N^*_{f,t} + N_{S,t})$, and $(N_{f,t} + N^*_{d,t})$ in the foreign country.

National GDP in each country is defined as:

$$\begin{aligned} GDP_{d,t} &= Y_{d,t} + Y^*_{f,t} + Y_{S,t} \\ GDP_{f,t} &= Y_{f,t} + Y^*_{d,t} \end{aligned} \tag{30}$$

The clearing condition for goods markets is the aggregation of domestic and foreign GDP:

$$\begin{aligned} GDP_{d,t} + GDP_{f,t} &= C_{d,t} + C_{f,t} + I_{d,t} + I^*_{f,t} + I_{S,t} + I_{f,t} + I^*_{d,t} + \frac{\chi_f}{1+\mu_f}\left(FA_{f,t} - FA_{f,t-1}\right)^{1+\mu_f} \\ &+ \frac{\chi_d}{1+\mu_d}\left(FA_{d,t} - FA_{d,t-1}\right)^{1+\mu_d} \end{aligned} \tag{31}$$

As explained in the previous subsection, bonds market clearing conditions are total deposits available in each country: the addition of household domestic savings and bonds purchases from abroad, which are nil from U.S. to China (under

the assumption of negligible reserve assets accumulation in the U.S.):

$$\begin{aligned} D_{d,T,t} &= \text{domestic bonds} + \text{bonds held by the U.S. } (=0) \\ &= B_{d,t} + B_{S,t} + FA_{f,t}(=0) \\ &= \zeta_d(K_{d,t} + K^*_{f,t}) + \zeta_S K_{S,t}. \qquad (32) \\ D_{f,T,t} &= \text{U.S. bonds} + \text{bonds held by China} \\ &= B_{f,t} + FA_{d,t} \\ &= \zeta_f(K_{f,t} + K^*_{d,t}) + FA_{d,t}. \qquad (33) \end{aligned}$$

with $FA_{d,t}$ comprising household and firms' savings invested in foreign bonds ($FA_{d,t} = B^*_{d,t} + \pi_{d,t} + \pi_{f^*,t}$).

There is one firm of each type by country in the model. It is the aggregation of n firms of type $d/f^*/S$ in the domestic country, and m firms of type f/d^* in the foreign country. Each type of firm has a share s of employment in the total of firms; it is fixed at the steady state but evolves endogenously after (for more details see the calibration section). It corresponds to the share of SOEs and inward/outward FDI (coefficients η_{Soe}, ω_{in} and ω_{out}). So for output, capital and investment, we get:

-with $s_k < 1 \in \{1 - \omega_{in} - \eta_{Soe}, \omega_{in}, \eta_{Soe}\}$ the employment share of firms of type k in the domestic country ($\forall k \in \{d, f^*, S\}$) :

$$Y_{k,t} = \int_0^{s_k}\int_0^{n} Y_{k,t}(i)\ di\ dj \qquad K_{k,t} = \int_0^{s_k}\int_0^{n} K_{k,t}(i)\ di\ dj \qquad I_{k,t} = \int_0^{s_k}\int_0^{n} I_{k,t}(i)\ di\ dj$$

-with $s_l < 1 \in \{1 - \omega_{out}, \omega_{out}\}$ the employment share of firms of type l in the foreign country ($\forall l \in \{f, d^*\}$):

$$Y_{l,t} = \int_0^{s_l}\int_0^{m} Y_{l,t}(u)\ du\ dv \qquad K_{l,t} = \int_0^{s_l}\int_0^{m} K_{l,t}(u)\ du\ dv \qquad I_{l,t} = \int_0^{s_l}\int_0^{m} I_{l,t}(u)\ du\ dv$$

The general equilibrium is defined as a sequence of variables that satisfy FOCs of firms and households, and market clearing conditions:

$$\left\{ \begin{array}{l} C_{d,t}, C_{f,t}, B_{d,t}, B_{S,t}, B^*_{d,t}, FA_{d,t}, B_{f,t}, B^*_{f,t}, FA_{f,t}, r_{d,t}, r_{f,t}, W_{d,t}, W^*_{d,t}, W_{S,t}, W_{f,t}, W^*_{f,t}, N_{d,t}, N^*_{d,t}, N_{S,t}, N_{f,t}, N^*_{f,t}, \\ Y_{d,t}, Y^*_{d,t}, Y_{S,t}, Y_{f,t}, Y^*_{f,t}, K_{d,t}, K^*_{d,t}, K_{S,t}, K_{f,t}, K^*_{f,t}, I_{d,t}, I^*_{d,t}, I_{S,t}, I_{f,t}, I^*_{f,t}, \pi_{d,t}, \pi^*_{d,t}, \pi_{S,t}, \pi_{f,t}, \pi^*_{f,t} \end{array} \right\}_{t=0}^{\infty}$$

Net Foreign Assets are obtained consolidating households and firms' budget constraints:

$$\begin{aligned} NFA_{d,t} = FA_{d,t} - FA_{f,t} + I^*_{d,t} - I^*_{f,t} = \left(B^*_{d,t} + \pi_{d,t} + \pi^*_{f,t}\right) - B^*_{f,t} + I^*_{d,t} - I^*_{f,t} \\ = \alpha_d Y^*_{d,t} - \alpha_f Y^*_{f,t} + (1 + r_{f,t})(1 - \gamma_f)\left(B^*_{d,t-1} + \pi_{d,t-1} + \pi^*_{f,t-1}\right) - (1 + r_{d,t})(1 - \gamma_d) B^*_{f,t-1} \\ -\frac{\chi_d}{1+\mu_d}\left[\left(B^*_{d,t} - B^*_{d,t-1}\right)^{1+\mu_d} + \left(\pi_{d,t} - \pi_{d,t-1}\right)^{1+\mu_d} + \left(\pi^*_{f,t} - \pi^*_{f,t-1}\right)^{1+\mu_d}\right] + \left[\frac{\chi_f}{1+\mu_f}\left(B^*_{f,t} - B^*_{f,t-1}\right)^{1+\mu_f}\right] \end{aligned} \tag{34}$$

In terms of consistency we have

$$NFA_{d,t} + NFA_{f,t} = 0.$$

The current account is defined as the sum of the trade balance and net income from abroad:

$$\begin{aligned} CA_{d,t} = TB_{d,t} + NIC_{d,t} = Y_{d,t} + Y^*_{f,t} + Y_{S,t} - C_{d,t} - I_{d,t} - I^*_{f,t} + I_{S,t} \\ + r_{f,t}(1 - \gamma_f)\left(B^*_{d,t-1} + \pi_{d,t-1} + \pi^*_{f,t-1}\right) - r_{d,t}(1 - \gamma_d) B^*_{f,t-1} \\ + \frac{\chi_f}{1+\mu_f}\left(B^*_{f,t} - B^*_{f,t-1}\right)^{1+\mu_f} - \frac{\chi_d}{1+\mu_d}\left[\left(B^*_{d,t} - B^*_{d,t-1}\right)^{1+\mu_d} + \left(\pi_{d,t} - \pi_{d,t-1}\right)^{1+\mu_d} + \left(\pi^*_{f,t} - \pi^*_{f,t-1}\right)^{1+\mu_d}\right] \end{aligned} \tag{35}$$

It can also be expressed as a function of savings and investments: $CA_{d,t} = S_{d,T,t} - I_{d,T,t} = \Delta NFA_{d,t}$, with $S_{d,T,t} = B_{d,t} + B_{S,t} + FA_{d,t}$ and $I_{d,T,t} = I_{d,t} + I^*_{d,t} + I_{S,t}$.

name	definition	name	definition
	In the domestic country (China):		In the foreign country (the U.S.):
$C_{d,t}$	consumption	$C_{f,t}$	consumption
$N_{d,t}$	labor supply in domestic private firms	$N_{f,t}$	labor supply in foreign private firms
$N^*_{f,t}$	labor supply in expatriated U.S. private firms	$N^*_{d,t}$	labor supply in expatriated Chinese private firms
$N_{S,t}$	labor supply in domestic SOEs		
$W_{d,t}$	wages in domestic private firms	$W_{f,t}$	wages in foreign private firms
$W^*_{f,t}$	wages in expatriated U.S. private firms	$W^*_{d,t}$	wages in expatriated Chinese private firms
$W_{S,t}$	wages in domestic SOEs		
$r_{d,t}$	real interest rate	$r_{f,t}$	real interest rate
$\pi_{d,t}$	profits of domestic private firms	$\pi_{f,t}$	profits of foreign private firms
$\pi^*_{f,t}$	profits of expatriated U.S. private firms	$\pi^*_{d,t}$	profits of expatriated Chinese private firms
$\pi_{S,t}$	profits of domestic SOEs		
$\pi_{d,T,t}$	total profits in the domestic country	$\pi_{f,T,t}$	total profits in the foreign country
$Y_{d,t}$	production in domestic private firms	$Y_{f,t}$	production in foreign private firms
$Y^*_{f,t}$	production in expatriated U.S. private firms	$Y^*_{d,t}$	production in expatriated Chinese private firms
$Y_{S,t}$	production in domestic SOEs		
$K_{d,t}$	capital in domestic private firms	$K_{f,t}$	capital in foreign private firms
$K^*_{f,t}$	capital in expatriated U.S. private firms	$K^*_{d,t}$	capital in expatriated Chinese private firms
$K_{S,t}$	capital in domestic SOEs		
$I_{d,t}$	investment by domestic private firms	$I_{f,t}$	investment by foreign private firms
$I^*_{f,t}$	investment by expatriated U.S. private firms	$I^*_{d,t}$	investment by expatriated Chinese private firms
$I_{S,t}$	investment by domestic SOEs		
$B_{d,t}$	bonds financing private firms in China	$B_{f,t}$	bonds financing private firms in the U.S.
$B_{S,t}$	bonds financing domestic SOEs		
$D_{d,T,t}$	total deposits	$D_{f,T,t}$	total deposits
$B^*_{d,t}$	foreign bonds from household savings	$B^*_{f,t}$	foreign bonds from household savings (=0)
$FA_{d,t}$	China's foreign assets, comprising: -foreign bonds from household savings ($B^*_{d,t}$) -foreign bonds from corporate savings ($\pi_{d,t}$ and $\pi^*_{f,t}$)	$FA_{f,t}$	U.S.' foreign assets (=0)
$NFA_{d,t}$	net foreign assets	$NFA_{f,t}$	net foreign assets
$CA_{d,t}$	current account	$CA_{f,t}$	current account

Note: parameters are described in the table of the calibration section.

Table 1: Variables

4. Calibration

The model is annual. The main objective of this calibration exercise is to reproduce the dynamics of inward FDI and the accumulation of foreign assets (the allocation puzzle of capital flows) but also of investment/saving rates and the consumption share over the last thirty years in China. It results from a transition of the Chinese economy from a high to low share of SOEs (economic liberalization) and from high to lower capital controls (financial liberalization). These economic and financial liberalizations are conducted under high TFP growth. Some parameters remain fixed over time while other parameters adjust along the way. All is summarized in Table 2.

4.1. Size of countries and firms

SOEs represented 85% of the employment share in China in the late 1980s, and then, 45% in 2008 (see Figures 13 and 14). The privatization of firms drove the transition, thus, an exogenous and decreasing share of employment in SOEs (η_{Soe}) is assumed in the economy to model the privatization process: it gradually shifts from $\eta_{Soe} = 75\%$ to 40% over the transition; the rest goes to private firms, and labor supplies in the domestic country become:

$$(\frac{N_{d,t}}{1-\eta_{Soe}})^{\psi} C_{d,t}^{\sigma} = W_{d,t} \qquad (\frac{N_{f,t}^{*}}{1-\eta_{Soe}})^{\psi} C_{d,t}^{\sigma} = W_{f,t}^{*} \qquad (\frac{N_{S,t}}{\eta_{Soe}})^{\psi} C_{d,t}^{\sigma} = W_{S,t}$$

This calibration remains close to the official data (a decreasing share of employment in SOEs from 85% to 45%; Source: China Statistical Yearbook, 2013) and the justification of the difference is twofold. (i) The more important is the variation of the employment share, which is of 40 percentage point in the data, against 35 percentage point in the model. It is more appropriate to calibrate the employment share in SOEs with a variation of 35 percentage point in the model to reproduce the evolution of the major variables. (ii) The data concerning the decreasing share of SOEs in total employment can have different values according to the data source or the selected sectors (industry or tertiary). Moreover, the definition of "privatization" or "public ownership" is not very clear in the data sources (there is sometimes the inclusion of foreign firms in the share of private firms; and we do not always know for which degree of public ownership a firm can be considered as "state-owned"). For all these reasons, there are error margins that can allow for a calibration of the SOEs' employment share in the model that is slightly different from the official data.

Individual labor demands and supplies are derived per capita in the model. Hours worked are normalized in equilibrium to fit the relative initial size of China and the U.S. at the beginning of the transition ($\varrho_Y = \frac{output_d}{output_d + output_f} = 0.05$). Then, it evolves endogenously (Chinese GDP reaches 31% of total GDP (China and the U.S.) at the end of the transition, 27% in the data). The shares of expatriate and local firms in China and the U.S. (ω_{in}, ω_{out}, $1-\omega_{out}$, and $1-\omega_{in}$) are set to match approximately the FDI-to-GDP ratios at the beginning of the transition (Table 2). Then, it also evolves endogenously. However, for outward FDI, it is impossible to match data values under the calibration in this framework, even at the beginning of the transition. It is not a crucial issue because it is not the main focus of the study, and qualitatively there is a decrease of outward FDI relative to GDP under a large part of the transition (corresponding to the data). Thus, labor supply, the marginal utility of consumption, trading costs, and market clearing conditions become:

$$
\begin{aligned}
\left[\frac{N_{d,t}}{(1-\eta_{Soe}-\omega_{in})\,\varrho_Y}\right]^{\psi}\left[\frac{C_{d,t}}{\varrho_Y}\right]^{\sigma} &= W_{d,t}\\
\left[\frac{N^*_{f,t}}{\omega_{in}\varrho_Y}\right]^{\psi}\left[\frac{C_{d,t}}{\varrho_Y}\right]^{\sigma} &= W^*_{f,t}\\
\left[\frac{N_{S,t}}{\eta_{Soe}\varrho_Y}\right]^{\psi}\left[\frac{C_{d,t}}{\varrho_Y}\right]^{\sigma} &= W_{S,t}\\
\left[\frac{N_{f,t}}{(1-\omega_{out})\,(1-\varrho_Y)}\right)^{\psi}\left[\frac{C_{f,t}}{(1-\varrho_Y)}\right]^{\sigma} &= W_{f,t}\\
\left[\frac{N^*_{d,t}}{\omega_{out}(1-\varrho_Y)}\right]^{\psi}\left[\frac{C_{f,t}}{(1-\varrho_Y)}\right]^{\sigma} &= W^*_{d,t}\\
\left[\frac{C_{d,t}}{\varrho_Y}\right]^{-\sigma} &= \lambda_{d,t}\\
\left[\frac{C_{f,t}}{1-\varrho_Y}\right]^{-\sigma} &= \lambda_{f,t}\\
\left[1+\chi_d\left(\frac{B^*_{d,t}}{\varrho_Y}-\frac{B^*_{d,t-1}}{\varrho_Y}\right)^{\mu_d}\right] &= \frac{(1+r_{f,t+1})\,(1-\gamma_f)}{(1+r_{d,t+1})\,(1-\gamma_d)}\\
Y_{d,t}+Y^*_{f,t}+Y_{S,t}+Y_{f,t}+Y^*_{d,t}-C_{d,t}-C_{f,t} &= I_{d,t}+I^*_{f,t}+I_{S,t}+I_{f,t}+I^*_{d,t}\\
+\frac{\chi_d.\varrho_Y}{1+\mu_d}\left[\left(\frac{B^*_{d,t}}{\varrho_Y}-\frac{B^*_{d,t-1}}{\varrho_Y}\right)^{1+\mu_d}+\left(\frac{\pi_{d,t}}{\varrho_Y}-\frac{\pi_{d,t-1}}{\varrho_Y}\right)^{1+\mu_d}+\left(\frac{\pi^*_{f,t}}{\varrho_Y}-\frac{\pi^*_{f,t-1}}{\varrho_Y}\right)^{1+\mu_d}\right] &\\
+\frac{\chi_f.(1-\varrho_Y)}{1+\mu_f}\left[(\frac{B^*_{f,t}}{1-\varrho_Y}-\frac{B^*_{f,t-1}}{1-\varrho_Y})\right]^{1+\mu_f} &
\end{aligned}
$$

4.2. Households

The calibration is classic for the discount rate β (0.97). A higher ψ (inverse of Frisch elasticity) in China is utilized to have more time spent at work (Source: The Conference Board Database). The risk aversion parameter σ is set to 1. Indeed, it is well known that with separable preferences, because the model is solved along the balanced growth path, labor supply equations force the risk aversion parameter to be equal to 1. The parameters of household preferences and firms' production are calibrated to have lower wages in China as compared to the U.S. for all types of firms: private (domestic and expatriate) and state-owned.

4.3. Firms

A higher depreciation rate of capital δ in China captures capital expropriation (which is not redistributed). According to Angang (2001, 2002), different types of corruption led to economic losses of approximately 13.3-16.9 % on average in the late 1990s. It is more frequent in SOEs than in private firms: δ_S, δ_d, and δ_f are, respectively, set to 0.15, 0.12, and 0.08. The lack of property rights protection also produces high capital losses in private firms. Therefore, the depreciation rate of capital in Chinese private firms is higher than in U.S. firms.

The model reproduces the Chinese transition from the 1980s with a low *initial* share of capital in production. The reasons are threefold. First, the beginning of the transition was mainly a reallocation of the labor force from the countryside, hence a low (resp. high) capital (resp. labor) share. Second, the first part of the transition in China was primarily driven by agricultural and construction sectors, which have a lower (resp. higher) capital (resp. labor) share (Bai and Qian, 2010). Third, the initial share of capital in production in China is not equal to that of Song et al. (2011), mainly because they start their simulations in a second step of the transition, in 1990s, while here it starts in 1980s. Moreover, the source of Song et al. (2011) is NBS (the China's National Bureau of Statistic), which, according to Bai et al. (2006), cannot indicate accurately the capital share. Indeed, the financing through shadow banking and investment vehicles (which are not in the model) makes the estimation difficult. Considering all of these elements, the calibration of capital share is initially set at the low level of 0.17. Then, in this model, the initial low capital share is (i) exogenously rising (which corresponds to the facts, see Bai and Qian, 2010) (ii) endogenously and quickly rising with the hugely relaxing credit constraints along the transition, *particularly for SOEs*, which fits the recent overinvestment.

Concerning TFP growth, it is calibrated to the 1980s in the first periods of the model and adjusts gradually over time for private Chinese firms to reach the TFP growth observed in the late 2000s. Thus, TFP growth is initially at 1% in Chinese private firms and increases until 4.5%, whereas TFP growth is initially at 0.7% for SOEs but it does not increase over time (Source: Brandt and Zhu, 2010). TFP growth is set at 0.3% in the U.S., that is, approximately the annual average for the 1990-2007 period (the maximum was at 2% and the minimum at -0.81%; Source: The Conference Board Database).

4.4. Credit market

Credit constraints have a calibration close to Coeurdacier et al. (2015). They are tight for private Chinese firms (in Equation 16, $\zeta_d = 0.02$ initially) while looser for SOEs and U.S. private firms (in Equation 17, $\zeta_{S/f} = 0.2$ initially). For simplicity, at the beginning of the transition, credit constraints of SOEs are regarded to be similar to U.S. ones. Then, credit constraints are relaxed all along the transition in China for all firms, but much more relaxed in SOEs. At the end of the liberalization, ζ is much (resp. slightly) higher in Chinese SOEs (resp. private firms) compared to U.S. firms. This is considering the recent significant overinvestment in Chinese SOEs (even if private firms could partly overcome it through shadow banking, see Tsai, 2002, Krugman, 2011, Li, 2014, and Funke et al., 2015). For the U.S., the access to credit ζ is not increasing across time, but firms get more indebted with financial capital flows coming from the high Chinese saving rate; it largely compensates the low (compared to China) ζ for the U.S. at the end of the transition. Moral hazard is higher in China: the ratio of defaulting loans, γ, is fixed at 12% in the model, which

corresponds to the mean of the available World Bank data (*Global Financial Development Database*); in the U.S., γ_f is set at 1%. Concerning capital controls in China, they are far from being only simple costs on bonds (Kimball and Xiao, 2006).[10] In the model, the magnitude and curvature of trading costs on bonds are set to match the data. Capital controls are assumed to be zero in the U.S. ($\chi = 0$), fall from $\chi = 0.4$ to $\chi = 0.02$ over the transition in China, and quadratic costs are considered (so $\mu_d = \mu_d = 1$).

4.5. Forces driving the transition

Some parameters evolve exogenously to drive the Chinese transition. The key parameter is TFP growth, therefore, a deterministic shock of the TFP growth rate is set during 30 years in Chinese private firms. It shifts from 1% to 4.5% (Brandt and Zhu, 2010). In addition, the liberalization is characterized in the model by: (i) an economic liberalization that is captured by having a gradual decrease in SOEs' share in employment (from 75% to 40% with a path of almost 1% per year; see the justification in Subsection 4.1) (ii) a financial liberalization, captured by having lower trading costs across time (from $\chi = 0.4$ to $\chi = 0.02$) (iii) an improvement in the access of firms to the credit market (ζ_{d/d^*} increases to 24% of capital, and ζ_{SOE} to 70%) (iv) by an increase in the capital to output ratio, captured by having a higher α over time (from 0.17 to 0.30; see the justification in Subsection 4.3). Thus, all firms have an increasing capital share across time, but more or less depending on the degree of credit constraints' loosening (thus, SOEs become more capital-intensive and private firms remain quite labor-intensive).

	Parameters	China	U.S.
Constant parameters			
β	discount rate	0.97	0.97
σ	intertemporal elasticity of substitution[1]	1	1
ψ	inverse of Frisch elasticity	4	1
μ	curvature of bonds trading costs	1	1
δ	capital depreciation rate (capital expropriation)	0.12 for private firms 0.15 for SOEs	0.08
γ	moral hazard (ratio of defaulting loans)	0.12	0.01
ϱ_Y	initial share of output (bilateral)	0.05	
ω_{in}	initial share of inward FDI (bilateral)	0.007	
ω_{out}	initial share of outward FDI (bilateral)	0.001	
Economic liberalization			
η_{Soe}	share of SOEs in employment	0.75 down to 0.4	0
Financial liberalization			
χ	bonds trading costs	0.4 down to 0.02	0 ($B_f^* = 0$)
Financial development			
ζ	credit constraint	0.02 up to 0.24 for private firms 0.2 up to 0.7 for SOEs	0.2
Transition			
gA	TFP growth	0.01 up to 0.045 for private firms 0.007 for SOEs	0.003
α	share of capital in production	0.17 up to 0.3	0.3

[1] It is well known that with separable preferences, because the model is solved along the balanced growth path, labor supply equations force the risk aversion parameter to be equal to 1.

Note: The transition lasts thirty years, and the adjustment in parameters values is gradual (linear) overtime.

Table 2: Calibration of the benchmark model

5. Results and sensitivity analysis

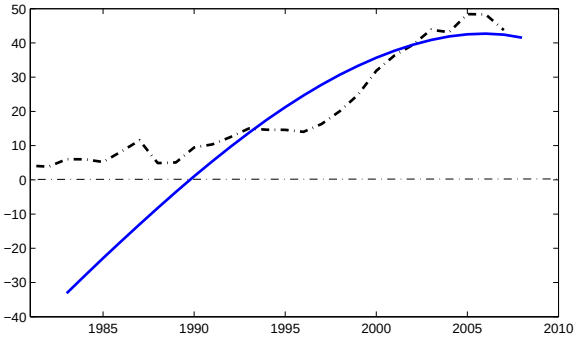
5.1. Results

The results are summarized in Figure 1 and Table 3. They report the evolution during the transition of key variables (current account and trade balance, foreign assets, inward/outward FDI, consumption, saving and investment). All of these variables are expressed in percentage of GDP. Note that for the data of trade balance and inward/outward FDI, China and the U.S. are considered *as the sole partners*: it is not against the rest of the world.

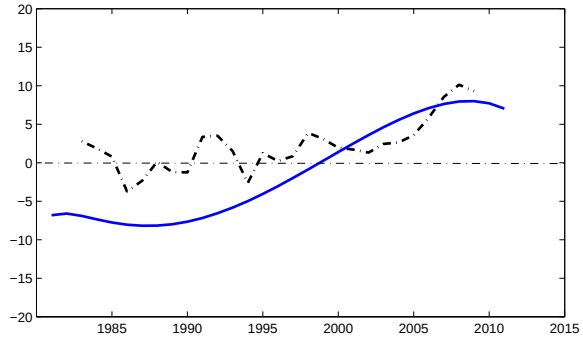
Variables (% GDP)	1985		1995		2006-2007	
	Model	Data	Model	Data	Model	Data
Current account	-7.5	$\simeq 0$	-4	1.5	7.5	8.5
Trade balance	-2.5	-0.25	8.9	1.38	11	4.35
Foreign assets	-23.2	4.6	20	14	41	46
inward FDI (bilateral)	0.225	NA	0.45	0.4	0.63	0.87
outward FDI (bilateral)	0.72	NA	0.62	0.15	0.39	0.015
Consumption share	71	63.5	60	44.5	45	39
Aggregate saving rate	-17	34	35	43	67	50
Aggregate investment rate	32	38	45	42	52	42

Table 3: Results (% GDP) - China

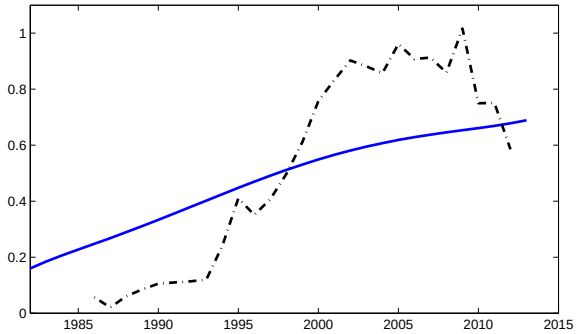
Foreign Assets (a)



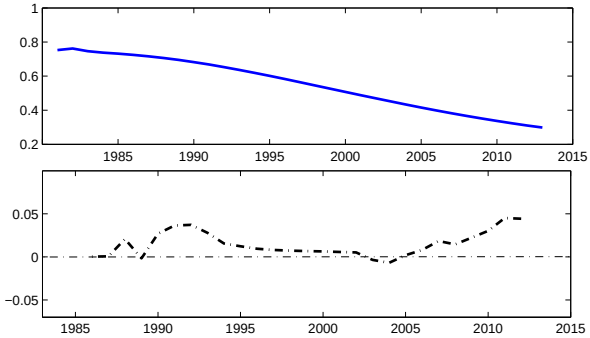
Current account (b)



inward FDI (c)

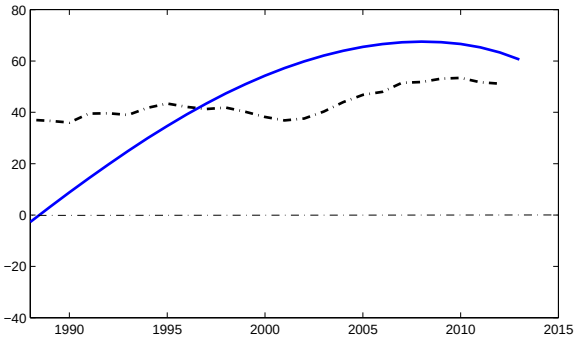


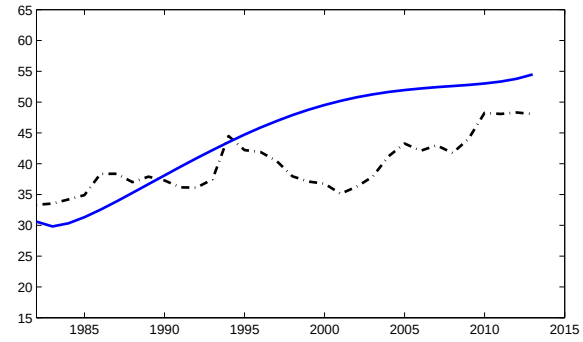
outward FDI (d)



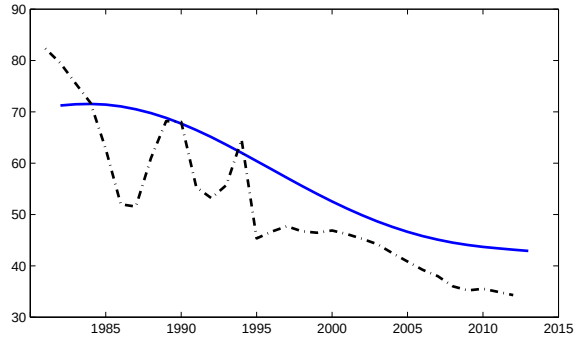
Aggregate saving rate (e)

Aggregate investment rate (f)





Consumption share (g)



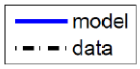


Figure 1: Results (% GDP) - China

5.1.1. The patterns of capital flows (FDI and Net Foreign Assets)

First, notice that the model starts with a negative value for net foreign assets in China (Figure 1, panel (a)), contrary to the data. The theory according to which capital flows from developed to capital scarce countries with high growth is initially verified: China is indebted to the rest of the world to finance its investment in fixed capital with high TFP growth. Indeed, all frictions that are specific to the Chinese economy are not fully implemented (it is gradual, see Table 2). Thus, the country borrows abroad to maintain its level of investment and domestic demand because the initial low level of household savings is not sufficient and the foreign interest rate is lower. Then, net foreign assets become positive as in the data. Before going into the details in the sensitivity subsection, the rise in foreign assets primarily results from the growing share of private firms that are not sufficiently financed (contrary to SOEs). Credit-constrained but more productive, these new labor-intensive firms export and accumulate profits, which are indirectly[19] saved abroad. Moreover, the large part of household savings is driven to SOEs all along the transition, but in the end, their saving rate rises and decreasing capital controls allocate more their savings to foreign bonds. This enhances the rise in the Chinese net foreign assets position.

Concerning FDI over GDP, inward FDI (panel (c)) are growing contrary to outward FDI (panel (d)).[20] The main explanation is a high (low) TFP growth and low (resp. high) wages in China (resp. in the U.S.), attracting expatriate firms in China. As for outward FDI, the model does not fit well the data but the pattern observed in the data is qualitatively reproduced, with a decreasing path during the major part of the transition (the recent and current rise in Chinese FDI outflows is a political strategy). Note that regarding inward FDI, their increase has slowed from 2000 (5.3% per year in 1995, 3.7% in 2012). Indeed, wages in China are at a higher level in 2000 than during the 1980s because of growth catch-up and progressively relaxing credit constraints.[21] The model does not match the recent drop of inward FDI in the data (only the FDI growth rate decreases), it is all the more surprising because wages of expatriate firms have a larger growth rate than domestic and U.S. wages (Figure 21). However, it can be explained by some elements that are still attracting inward FDI: profits in private firms remain high (Figure 20), credit constraints are progressively relaxed, and the path of TFP growth rate is constant at a high level even at the end of the transition.

[19] See details in the paragraph on firms' savings in Subsection 3.2. This assumption is equivalent to consider that the government uses the profits of firms that export a lot (the more productive and labor-intensive private firms) to buy foreign bonds, which is *indirectly* equivalent to the accumulation of foreign reserves by the central bank. In reality, Chinese savings are invested in foreign bonds through the central bank and sovereign wealth funds, but it is not the main focus here. This step is skipped in the model to maintain a simple framework. These *indirect* holdings of foreign assets by private firms are mentioned in Benhima (2013, p. 325), who also highlights the parallel trend of bank deposits and reserves (China Statistical Yearbook and Song et al., 2011).

[20] In absolute terms (not relative to GDP) the simulation predicts that inward and outward FDI are both growing: 182% against 15% over the last fifteen years. In terms of stocks over GDP, inward FDI are growing whereas outward FDI are decreasing; it is due to a higher balanced growth path in China compared to the capital growth of Chinese firms located in the U.S.

[21] Wages in private firms exceed those of SOEs, which is consistent with the study of Démurger et al. (2012) for the period 2002-2007.

Concerning the low level of FDI over GDP, it is important to remember that China and the U.S. are considered as the sole partners: it is not against the rest of the world (in this case, the stock of inward FDI would be close to 21% of GDP in China in 2005, and the stock of outward FDI close to 3% of GDP).[22]

Relaxation of the assumption on private firms' profits:

If the assumption that firms' profits and savings are invested abroad[19] is relaxed, the share of foreign assets explained by the profits of firms becomes nil, so the net foreign assets position is equal to 24.6% of GDP in 2006 (against 40.1% of GDP when the assumption is not relaxed, see Figure 2). Indeed, in the model household savings explain 60.2% of the NFA position in 2006 (24.6 percentage points) against 39.8% for firms' profits (15.5 percentage points). The relaxation of this assumption does not change the evolution of the other variables because the accumulation of firms' profits *is not embedded in the budget constraint of firms* (see the paragraph on firms' savings in Subsection 3.2).

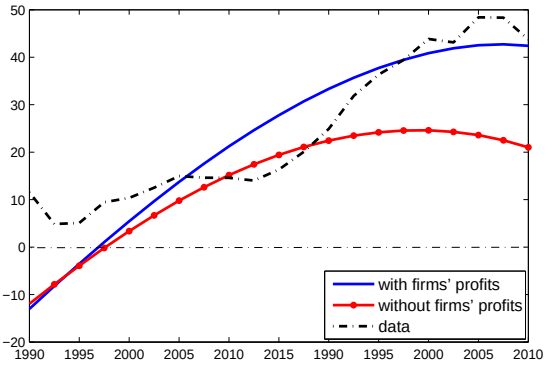


Figure 2: Foreign assets without private firms' profits (% GDP) - China

5.1.2. The drop in the consumption share

In the model, it is mainly due to financial intermediation. Indeed, credit constraints for SOEs are highly relaxed along the transition. It modifies capital and labor intensities in the different types of firms: private firms (domestic and foreign expatriated) become labor-intensive whereas SOEs capital-intensive. Household consumption is impacted through two channels.

(i) Wage growth in private firms should be strong because of their TFP growth, however, high credit constraints in these private firms hinder wage growth (Figure 3) and thus consumption growth too (Figure 5). In addition, this effect is even more important knowing that the share of private firms is increasing during the transition (see the calibration

[22]Source: OECD data

section). Thus, the low wage growth does not follow the high GDP growth and the consumption share is strongly decreasing.

(ii) The second channel by which financial intermediation affects consumption is returns on bonds. Indeed, the overborrowing of SOEs directs a large part of household savings to domestic bonds with low returns (Figure 4 shows that returns on bonds are lower when SOEs have a better access to credit).[23] These low returns on SOE bonds hinder consumption growth (Figure 5). However, the wealth effect is not strong with an elasticity of substitution equal to 1 (the latter is forced by the balanced growth path in the labor supply equation), but is not nil with the utility function that is used in the model $\left(\frac{C_{d,t}^{1-\sigma}}{1-\sigma} - \frac{N_{S,t}^{1+\psi}+N_{d,t}^{1+\psi}+N_{f,t}^{*1+\psi}}{1+\psi}\right)$.[24] Thus, the impact of returns on bonds on consumption exists but is not so important compared to the effect of the hindered wage growth in the increasing share of private firms.

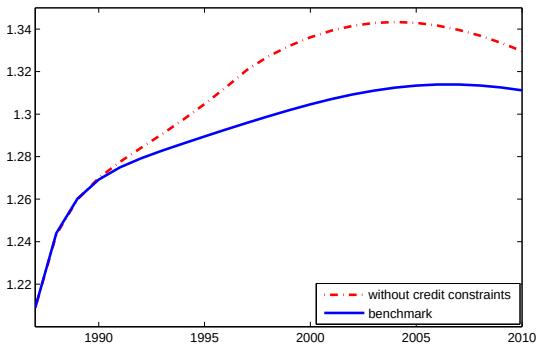


Figure 3: Wage index in domestic private firms
along the balanced growth path
(with and without credit constraints)

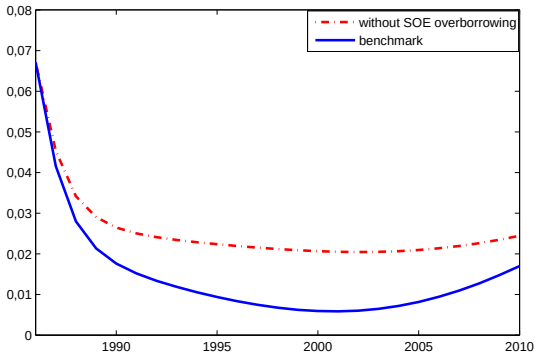


Figure 4: Domestic deposit rate
(with and without SOE overborrowing)

As for U.S. consumption and savings, note that they do not fit the data well (even if $C_{f,t}$ is rising in the second part of the transition). First, this does not come as a surprise as our main focus is China. Second, relaxing the assumption that $B_{f,t}^{*} = 0$ would increase the U.S. external debt and thus raise the consumption share in the U.S., but the negative external position of the U.S. would be too large.

[23] This channeling of household savings to SOEs is forced in the model (Equation 17) and also in reality.

[24] Note that the wealth effect would be stronger with another utility function, for example with $\frac{\left[C(1-N)^{1-\epsilon}\right]^{1-\sigma}}{1-\sigma}$.

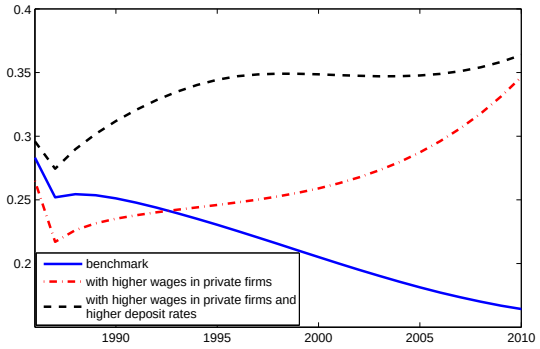
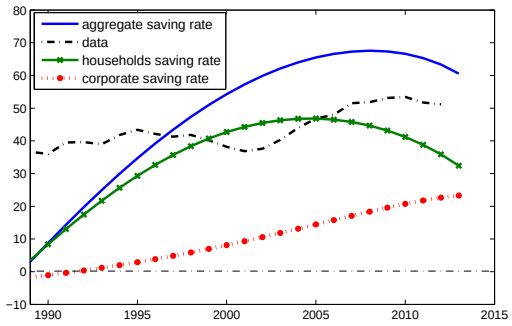


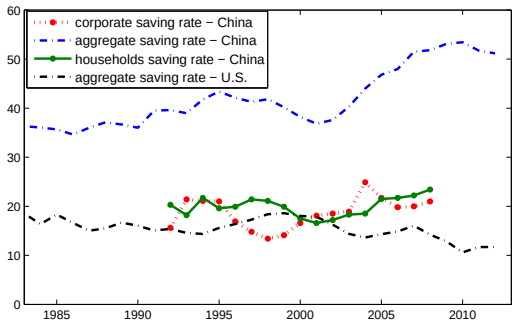
Figure 5: The reaction of consumption to wages and deposit rates
(*in consumption units*)

5.1.3. Other variables

The aggregate savings rate is nearly equally shared by households and firms at the end of the transition (Figure 6). It is consistent with the data of the last fifteen years and with some works such as Bayoumi et al. (2010) and Ma and Yi, 2011, among others. Although the household saving rate in the model becomes closer to the data in the last years of the transition, it remains too high in the model in the middle of the transition. It is primarily due to capital controls on foreign bonds purchases that cannot be perfectly accurate in this model, but also because some determinants of households savings are lacking (which can give too much importance to other explanations in the middle of the transition). Note that household aggregate savings rate is $SH_d = B^*_{d,t} + B_d + B_S$ and that of firms $SF_d = \pi_d + \pi^*_f$. Regarding the current account, it is driven by the trade balance and net income: $CA_{d,t} = TB_{d,t} + NIC_{d,t}$. The former



Model and data



Data (Ma and Yi, 2011; World Bank)

Figure 6: Saving rates (% GDP) - China

quickly becomes positive and large because of an output surge and a slowdown in private firms' investment. In the late 1990s, the current account exceeds the trade balance. It is because China is not indebted to the U.S. anymore,

and there is a fast rise in returns on foreign bonds. As the magnitude of trading costs (χ_d) decreases progressively, net income drives the current account up to a level close to 10 % of GDP at the end of the transition:

$$\begin{aligned} NIC_{d,t} &= r_{f,t}\left(1-\gamma_f\right)\left(B^*_{d,t-1}+\pi_{d,t}+\pi^*_{f,t}\right)-r_{d,t}\left(1-\gamma_d\right)B^*_{f,t-1} \\ &\quad -\frac{\chi_d}{1+\mu_d}\left[\left(B^*_{d,t}-B^*_{d,t-1}\right)^{1+\mu_d}+\left(\pi_{d,t}-\pi_{d,t-1}\right)^{1+\mu_d}+\left(\pi^*_{f,t}-\pi^*_{f,t-1}\right)^{1+\mu_d}\right] \end{aligned}$$

After 2007, looser credit constraints in China allocate household savings more significantly toward domestic bonds of private firms. Thus, it reduces the purchase of foreign bonds and the current account, and enhances the growth of the investment rate (after 2010).

As mentioned in the model section, there are no prices of goods, nominal rigidities, or value function for bond prices to keep the model simple. However, relative costs can give an approximate idea of the real exchange rate evolution. The variable below reproduces the weighted relative evolution of domestic and foreign wages:

$$rw_t = \frac{\omega_{in,t}.W^*_{f,t}+(1-\omega_{in,t}-\eta_{Soe}).W_{d,t}+\eta_{Soe}.W_{S,t}}{\omega_{out,t}.W^*_{d,t}+(1-\omega_{out,t}).W_{f,t}} \tag{36}$$

with $\omega_{in,t}=\frac{K_{f^*,t}}{K_{d,T,t}}$, $\omega_{out,t}=\frac{K_{d^*,t}}{K_{f,T,t}}$ and parameter η_{Soe} that exogenously decreases.

Relative labor costs are far below the real effective exchange rate during the first part of the transition (this large gap with the data can be explained by the initial calibration of the capital share at a low level). Then, the model approximation of the real exchange rate follows the slowly increasing trend of the data while it remains below (Figure 7). Even if these relative wages are just an approximation of the real exchange rate, it also means that there is a downward pressure on the evolution of labor costs compared to the U.S. during the transition, which is particularly due to the lower capital share and initial level of technology, to higher capital depreciation and to tighter credit constraints (see the definition of wages at steady state in Appendix B). Moreover, these relative labor costs are far from the relative TFP evolution. Indeed, in the model, TFP grows on average nearly eight times faster each year in China compared to the U.S. (six in the data), whereas only five percent faster each year for Chinese wages compared to the U.S. ones. These productivity gains are not followed by the corresponding increase in labor costs, explaining a large part of the foreign surpluses but also the decrease in the consumption share. This downward pressure on labor costs during all the transition in the model while TFP growth remains high is meaningful: even if the literature has demonstrated the existence of an exchange rate manipulation during a part of the transition (particularly between

2002 and 2005, see Coudert and Couharde, 2007, and Subramanian, 2010, among others), it is difficult to conclude that the Chinese growth and external surpluses mostly relied on it.

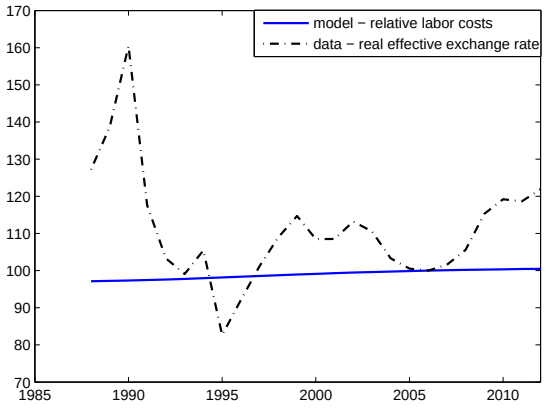


Figure 7: Relative labor costs and real effective exchange rate - China (Source: BIS statistics)

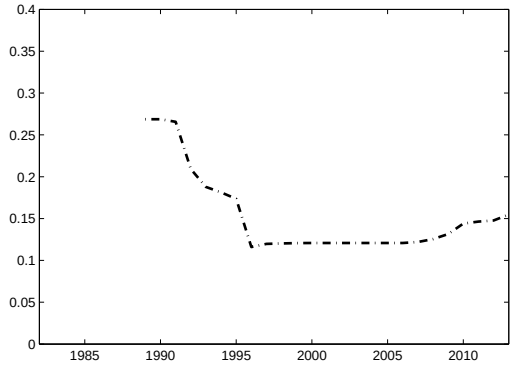


Figure 8: Official exchange rate - Source: World Bank

To summarize, the misallocation of household savings to SOEs to the detriment of private firms is the main element explaining both the two-way capital flows in China and the drop in the consumption share. Indeed, credit constraints in private firms hinder wage growth despite the high TFP growth, thus profits are high and FDI are massively attracted. These profits in the growing share of private firms are invested in foreign bonds, creating a significant part of the positive net foreign assets position. The other part of the latter is due to the increasing household saving rate. Indeed, consumption is hindered by low returns on SOE bonds (that facilitate SOE overborrowing) and by low wage progression in the rising share of credit-constrained private firms. Thus, the consumption growth does not follow the GDP growth and the consumption share decreases. Capital controls have a role, but just at the end of the transition, by enhancing the allocation of household savings to foreign bonds. The other frictions, moral hazard and capital expropriation, are not at the origin of the capital misallocation but also have an impact. Capital expropriation magnifies corporate savings rates, and moral hazard particularly decreases returns on bonds, and slows the increase in FDI inflows and the aggregate investment rate.[25]

To determine the contribution of each assumption and friction, we proceed to a systematic sensitivity analysis. Each friction and assumption is removed and the resulting dynamics are compared to the benchmark.

[25]The investment rate is already very high in China in the model and in the data, however, it would be even higher if credit frictions were reduced.

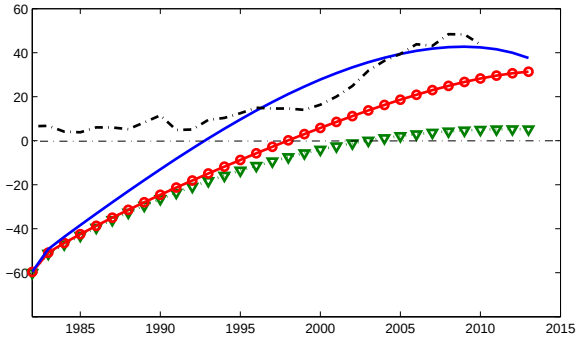
5.2. Sensitivity

5.2.1. SOEs and trading costs: the economic and financial liberalization

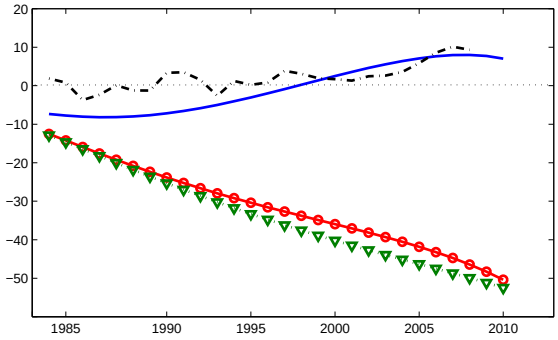
In the model, the economic liberalization corresponds to the privatization process in China, that is, a decrease in the share of employment in SOEs (η_{SOE}) from 75 % to 40 % during the transition. Financial liberalization is similar to a decrease in capital controls (the magnitude of trading costs goes from 0.4 to 0.02). The specific effects of economic and financial liberalization can be identified by comparing the benchmark with the equilibrium where one or both assumptions are relaxed. Before going into more details, some key points about the impact of liberalization on the results (Figure 9) may be summarized. First, under heterogeneous credit constraints and TFP growth across firms, the transition from SOEs to private firms is the key element creating external surpluses. Indeed, as banks finance more SOEs through household savings, the share of private labor-intensive firms is growing. Their low access to credit slows their investments and the progression of wages but they make profits with their high TFP growth; these profits are saved abroad and thus create large foreign assets and current account surpluses, in line with Song et al. (2011). Second, the external financial surplus is just amplified by decreasing capital controls during the transition, but is not created by the financial liberalization. Third, the economic liberalization has a significant impact on consumption in this model; it is clear on panel (g) in Figure 9: the consumption share remains constant or even increases without economic liberalization, whereas strongly decreases in the benchmark model. Indeed, during the transition, the loosening of credit constraints in SOEs mechanically raises household savings with low returns on bonds but wage growth in the rising share of private firms is still hindered: these elements cause the consumption share to decrease. Another major result is the dynamics of the current account that is reversed *without* economic liberalization (panel (b)): a constant and high rate of well-financed SOEs promotes a growth based on imports and indebtedness.

We now describe the effects of the economic liberalization on each variable, starting with foreign assets. The share of SOEs in the economy crucially affects both household and corporate savings, building up external surpluses. This effect is just magnified by the financial liberalization. Both effects appear clearly in Figure 9 (panels (a) and (b)) where both assumptions are relaxed. Initially, under all scenarios, the Lucas Paradox (1990) does not appear *at the beginning of the transition* because the initial share of SOEs is very large. This initial assumption of a large share of SOEs is equivalent to low aggregate credit constraints in China (as $\zeta_{SOE} > \zeta_{d/d^*}$), and thus to an economy based on imports and indebtedness. Combined with low foreign interest rates, China borrows abroad (despite strong capital controls) to maintain its initial levels of consumption and investment. Then, in the benchmark, with the increasing share of private and credit-constrained firms, the allocation of household savings to SOEs creates labor-intensive firms.

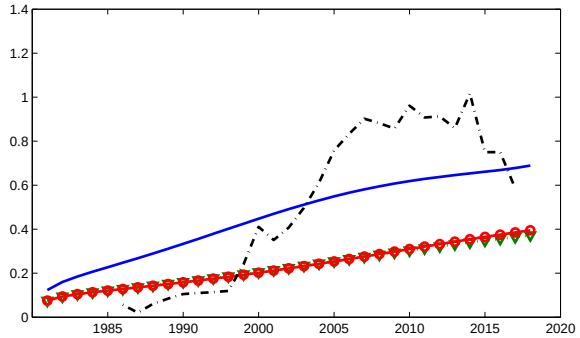
Foreign Assets (a)



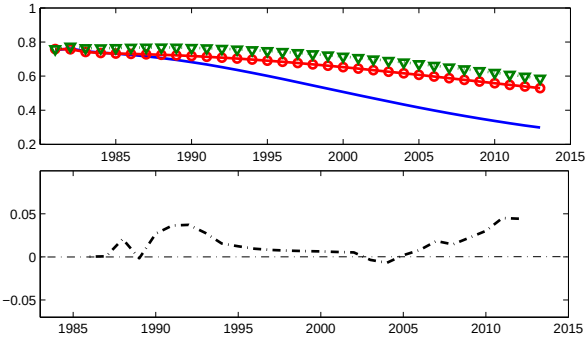
Current account (b)



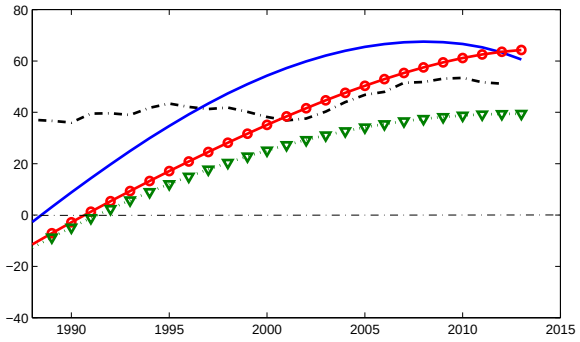
inward FDI (c)



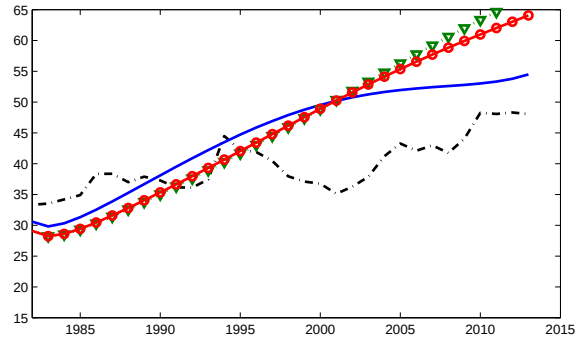
outward FDI (d)



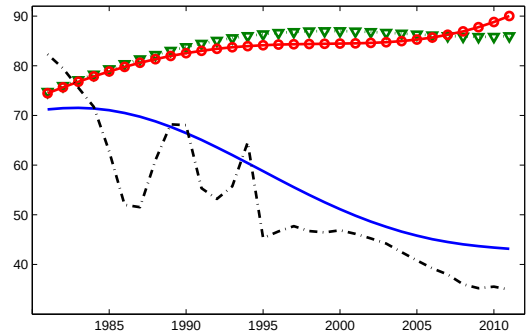
Aggregate saving rate (e)



Aggregate investment rate (f)



Consumption share (g)



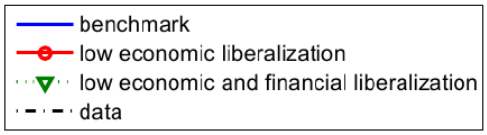


Figure 9: The impact of economic and financial liberalization (the share of employment in SOEs and capital controls), results in % of GDP - China

In the benchmark, profits become higher in these private firms because of high TFP growth (as in the data, see Figure 19), and these new savings tend to be invested abroad.[19] This mechanism is amplified over time with the rising share of SOEs and financial liberalization: the amount of foreign assets relative to GDP increases along the transition (see the benchmark in Figure 9, panel (a)). These effects are clearly reversed when both assumptions are relaxed. The increasing share of credit-constraints private firms also changes the consumption and savings behavior of households. The latter work more in private firms across time, with a wage growth hindered by credit constraints (Figure 3 in the previous subsection), which raises their savings (Figure 9, panel (g), and Figure 6 in the previous subsection). In addition to lower capital controls across time with financial integration, foreign assets reach a higher level (Figure 9, panel (a)). Note that if households could really trade-off between SOE bonds (with low returns) and domestic private firm bonds and foreign bonds (with higher returns), it would change their consumption behavior. As a matter of fact, the trade-off is distorted by the fixed amount firms can borrow (binding credit constraints, see Equations 17 and 17), an amount globally attributed to SOEs.

The decreasing share of SOEs is, therefore, the main reform explaining capital misallocation (coupled with a deficient financial intermediation), as in Song et al. (2011), and financial liberalization enhances the effect.

Regarding the current account, it is severely decreasing without economic liberalization because of a constant and high rate of capital-intensive SOEs (the growth is based on indebtedness and not on exports when there is no privatization of firms). Thus, the aggregate investment rate rises faster at the end of the transition (panel (f)), but the gain in GDP remains low as SOEs' TFP growth is not as high as that of private firms. This result without liberalizations highlights that the current account surplus in China is mainly driven by an increasing share of credit-constrained private firms. The impact of financial integration on the dynamics of the current account through net income is not quantitatively negligible (particularly between 1995 and 2007, see the difference between the green and red lines), but does not drive it qualitatively. Moreover, consumption also tends to raise the deficit of the current account when there is no privatization (panel (g)). Indeed, if the share of SOEs remains high during the entire transition, the consumption share remains constant because GDP remains low without the rising share of private firms with high TFP growth. Like the other variables, the effect of economic liberalization on consumption is just amplified by the financial liberalization, but the latter is not crucial. As for the fall in the consumption rate when there is no relaxed assumption, it is well detailed in the results subsection above.

Regarding FDI, the decrease in the share of SOEs obviously raises (resp. reduces) inflows (resp. outflows) with

the opportunity for private firms to invest with high TFP growth and low wages (Figure 9, panels (c) and (d)).[26] This increase in inward FDI growth rate with privatization can partly offset the slowdown of private firms' investment (due to tight credit constraints and other elements described later) and savings accumulation; it is the result of Ju and Wei (2010). Then, inward FDI remain attracted by the high local TFP growth but they are slowed by growing wages.[27] The impact of financial integration is weak but lower trading costs reduce (resp. raise) FDI inflows (resp. outflows) in (resp. from) China. Indeed, the rise in the purchase of U.S. assets by China expands the funding of U.S. firms. It is to the detriment of opportunities in China through expatriate firms.

5.2.2. Credit market frictions

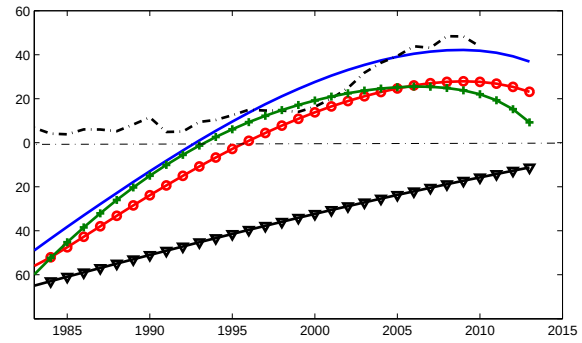
We now comment on the specific effects of credit market frictions. Figure 10 contrasts the respective contribution of credit constraints and moral hazard (the ratio of defaulting loans) by removing one or both of the assumptions together. Looser credit constraints for private firms mean an increase in the capacity to borrow ζ_d from 0.2 to 0.4 compared with 0.02 to 0.2 initially. A low moral hazard means an increase in loans repayments, $(1+r_{d,t})(1-\gamma_d)$, and is equivalent to $\gamma_d = 0.06$ ($\gamma_d = 0.12$ initially).

As for credit constraints, in the benchmark model, they increase aggregate savings and slow the growth rate of domestic investments (Figure 10, panels (e) and (f)), in line with the literature on global imbalances. Moreover, as in Song et al. (2011), heterogeneous credit constraints cause SOEs to be capital-intensive (because of a better access to credit), and private firms labor-intensive (because of a low access to credit). The decreasing share of SOEs leads to a large proportion of labor-intensive and credit-constrained firms. In the model, it maintains wages at a low level in private firms, attracting inward FDI (Figure 10, panel (c)); however, looser credit constraints also slightly decrease FDI inflows because they raise wages in foreign firms in China (Figure 22 in Appendix C). In the benchmark, the labor-intensive and credit-constrained firms make profits with their large TFP growth and low labor costs, and the corresponding corporate savings are amplified by larger credit constraints. Therefore, the latter raise the external financial position. Thus, when credit constraints become looser, it is clear that the aggregate savings rate, the NFA, and the current account are reduced and that the domestic investment rate increases (Figure 10). One issue with the

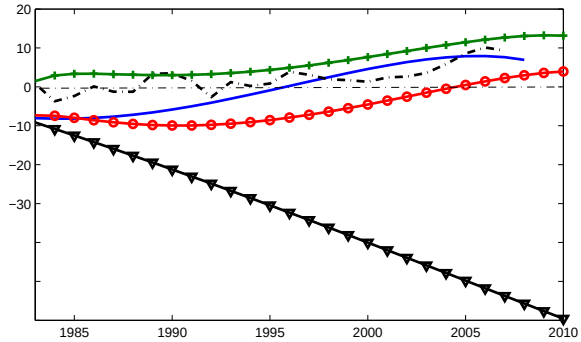
[26] In terms of stock amount (not relative to GDP), inward and outward FDI are both growing: 182% against 15% during the last fifteen years. In terms of stocks over GDP, inward FDI are growing whereas outward FDI are decreasing; it is due to a higher growth path of GDP in China compared to the growth of its capital located in the U.S.

[27] Initially, wages in China are of course lower than U.S. ones under this calibration. More precisely, those in foreign expatriated firms are initially higher than in domestic private ones and SOEs. Indeed, the initial technology and share of capital in production are higher in U.S. expatriated firms in China. In dynamics, wages in these firms are growing faster than in domestic private firms; it is due to a higher share of capital in production combined with high TFP growth, see steady state and dynamics equations of wages in Appendices A and B.

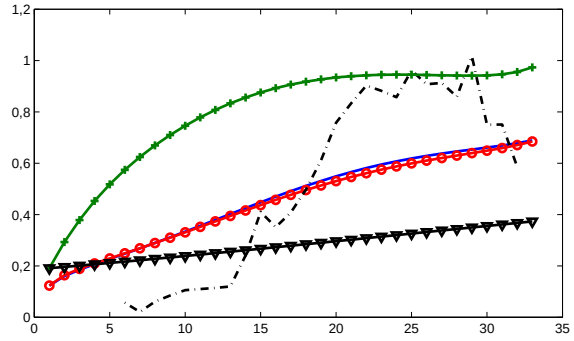
Foreign Assets (a)



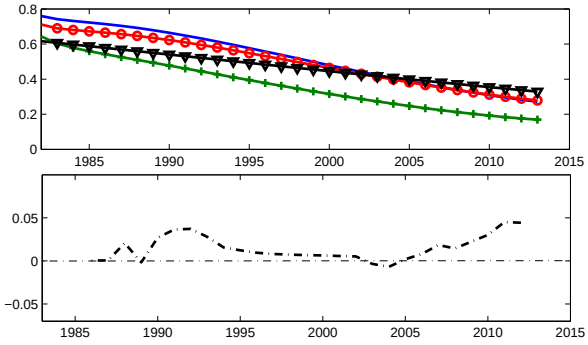
Current account (b)



inward FDI (c)

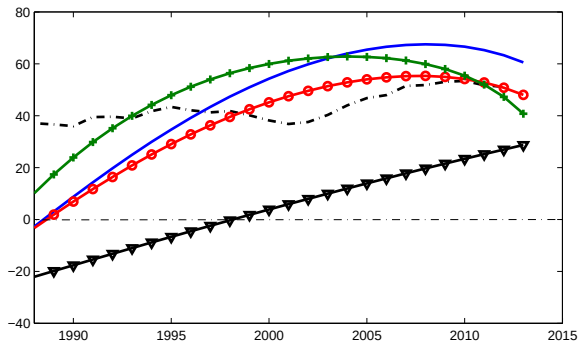


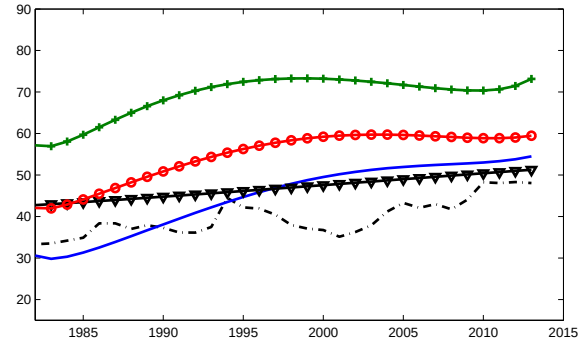
outward FDI (d)



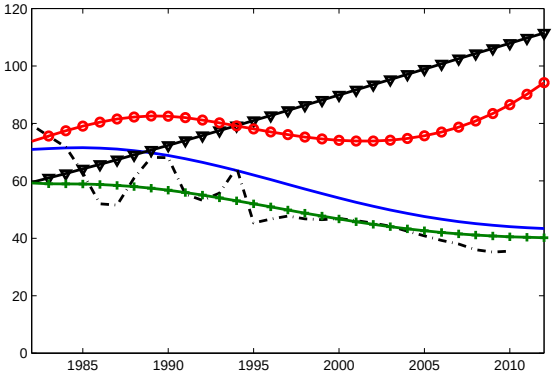
Aggregate saving rate (e)

Aggregate investment rate (f)





Consumption share (g)



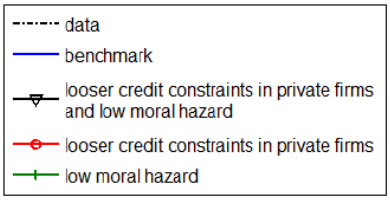


Figure 10: The impact of credit market frictions (credit constraints and moral hazard), results in % of GDP - China

high share of labor-intensive firms in China is the rise in wages due to financial development (looser credit constraints): it decreases FDI inflows, so it enhances the net external financial position (when FDI and foreign assets are aggregated, net capital flows are $FA_d - FA_f + I_{d^*} - I_{f^*}$).[28] Regarding the consumption share, it is positively impacted by looser credit constraints for private firms (Figure 10, panel (g)) because wage growth in an increasing share of private firms becomes higher (Figure 3 in the previous subsection).

Regarding moral hazard, this credit market friction is not well studied in the literature of global imbalances. In the benchmark model, its impact on foreign assets operates through two channels. First, lower moral hazard in the U.S. increases returns on foreign bonds and directly encourages China to buy them (Equation 7), once the major part of its savings is used to finance domestic firms (especially SOEs). Second, higher moral hazard in China raises the net external financial position because it discourages investment in domestic private firms or through FDI (Figure 10, panels (c) and (f)), as in Ju and Wei (2010). Indeed, there is a surge in the domestic real interest rate under a context of high moral hazard, which raises the cost of credit for firms. The borrowing interest rate becomes lower than the return on domestic investments; thus, corporate savings from labor-intensive firms increase, and so do the accumulation of foreign assets and the current account (Figure 10, panels (a) and (b)). When the assumption that moral hazard is high in China is relaxed (that is, higher loans repayments $(1 + r_{d,t})(1 - \gamma_{d/S})$, particularly for SOEs), Figure 10 exhibits an increase in inward FDI, investment and capital accumulation. However, lower moral hazard decreases firms' expatriation to the U.S. (outward FDI). Indeed, the high level of moral hazard in the benchmark model discouraged firms to invest domestically (i.e., in China), raising their share of capital expatriated (i.e., in the U.S.). The observed decrease in moral hazard (the ratio of defaulting loans) in the data since 1994 may be an explanation for the lower growth rate of outward FDI compared to inward FDI (in absolute terms) in China.

In the model, moral hazard amplifies the effect of credit constraints.[29] Indeed, foreign assets have a lower level when each credit market friction is separately looser, and when the two frictions are together less important, the negative effect on foreign assets is larger than the sum of the two separate effects (Figure 10, panel (a)). It is the same for the saving rate. Regarding inward FDI growth rate, it is slightly reduced when the assumption that credit constraints are high is relaxed, whereas largely increased when moral hazard is low. However, when the two frictions are softened, the effect of credit constraints overturns the effect of moral hazard and is amplified (Figure 10, panel

[28] That is why a rise in financial development would not be a solution to largely reduce global imbalances, as mentioned by Martin and Ventura (2012) (when capital flows are aggregated as it is the case in their study).

[29] It extends the result of Martin and Taddei (2013) to moral hazard instead of adverse selection. In their paper, adverse selection and limited pledgeability are the two credit market frictions at the origin of capital outflows, one friction amplifying the effect of the other.

(c)). The adjustment pattern of the current account is similarly affected. Indeed, low moral hazard increases the current account, and looser credit constraints produce deficits.[30] When the two credit market frictions are relaxed, there is a large drop in the current account as the effect of credit constraints overturns the effect of moral hazard and is amplified (Figure 10, panel (b)). As an explanation, higher credit constraints for private firms, as described previously, is the key element creating the current account path from deficits to high surpluses (Figure 9, panel (b)). However, moral hazard is just amplifying the external surpluses but is not at the origin. Therefore, in this framework, the loosening of both credit frictions is amplifying the effect of looser credit constraints.

5.2.3. Capital expropriation and the share of capital in production

This part highlights the effects of shifts in some classic parameters on firms' savings/investments: capital depreciation and the share of capital in production. These parameters are proxies for capital expropriation and capital intensiveness in firms, respectively. It is a simple approach but not often studied in the literature of global imbalances.[31]

As explained in the previous sections, the depreciation of capital δ is a proxy for capital expropriation in the model. In this context, it captures losses in capital with corruption, even if in the model, there is no redistribution of the expropriation (it is a fraction of capital at time $t-1$ which "disappears" at time t). Its role is similar to the coefficient in front of returns on investments in the static model of Ju and Wei (2010): when its value is high, investments in the real economy are reduced, so it has a direct effect on savings and capital flows. As Ju and Wei call it in their paper, it creates the "bypass of domestic institutions": firms avoid investing through domestic institutions. In the benchmark, it is assumed that δ_S (0.15) $>$ δ_d (0.12) $>$ δ_f (0.08). Corruption is mainly present in SOEs (high δ_S). In Chinese private firms, δ_d is also higher than in U.S. firms due to the lack of property rights protection. The case of low capital expropriation assumes that $\delta_S = \delta_d = \delta_f = 0.08$. The results are intuitive: low capital expropriation increases returns on investments, therefore, decreases corporate savings (Figure 12) and the external financial position (Figure 11, panel (a)), and even more raises the investment rate (panel (f)). Note that the *aggregate* savings rate (Figure 11, panel (e)) slightly rises when capital expropriation is low. The latter decreases *corporate* savings (Figure 12) but increases *household* savings. Indeed, there is more capital accumulation under low capital expropriation, which

[30] For the rise in the current account with low moral hazard, it comes from higher investments in high productive firms. The trade balance increases because the output growth rate is higher than investments growth rate. The increase in the current account does not come from a larger net financial income, since returns on foreign bonds are impacted by foreign moral hazard.

[31] See Jin (2012) for the share of capital in production and the link with the allocation puzzle of capital flows. Regarding capital expropriation, Ju and Wei (2010) consider it through low property rights protection. The latter decreases returns on investments and raises corporate savings flowing out of the country. However, as their model is static, their approach is not conducted through the law of motion of capital and its depreciation rate, as is the case here.

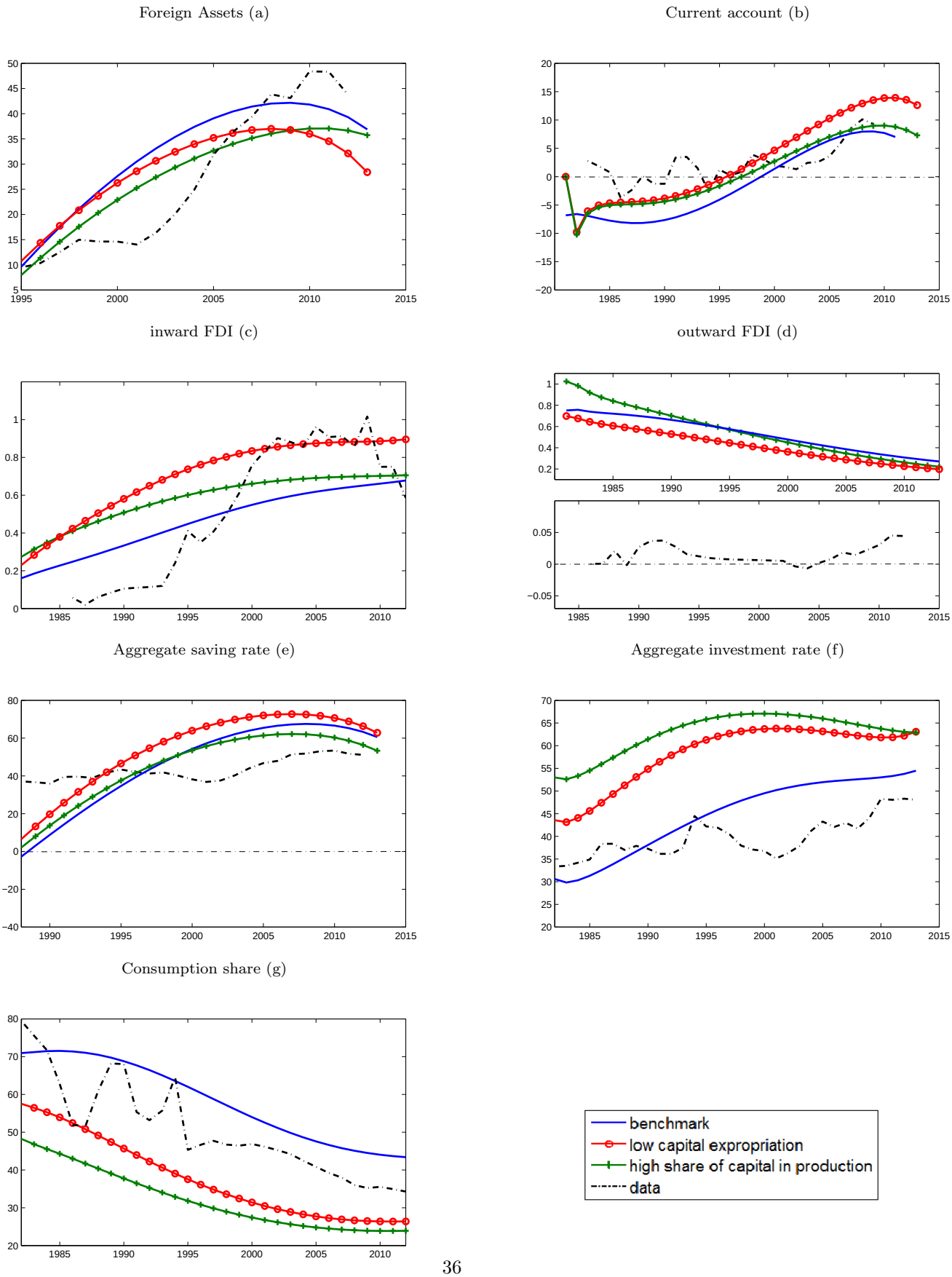


Figure 11: The impact of capital expropriation and the share of capital in production, results in % of GDP - China

raises the amount firms can borrow. It mechanically raises the purchases of domestic bonds by households in this model.

The impact on FDI is also intuitive: inward FDI increase and outward FDI decrease when there is less capital expropriation (Figure 11, panels (c) and (d)). The marginal product of capital is higher (with the same level of credit costs), so investments are more attractive in China. As for consumption (panel (g)) when capital expropriation is low, capital accumulation by firms rises, which increases the amount they can borrow. Thus, purchases of domestic bonds by households directly rise in the model, and the consumption share falls.[32]

Regarding the share of capital in production α, its value determines if a firm is intensive in labor or in capital, but without considering the impact of credit constraints. As the latter also determine if a type of firm becomes labor intensive or not, it is difficult to conclude on the specific impact of α. However, some deviations from the benchmark can be interpreted. The initial calibration sets a low (high) α in China (U.S.), and its impact is similar to that of capital productivity: when capital is well allocated and enters into production, investment and output rise. When the capital share in China is closer to the capital share in the U.S., corporate savings and foreign bonds purchases are reduced. It also leads to a higher inward FDI growth rate at the beginning of the transition (with a similar final level), and the share of outward FDI in GDP becomes larger (Figure 11). Obviously, the reaction of foreign assets and FDI would be different if all types of firms had a large access to credit and were intensive in capital.

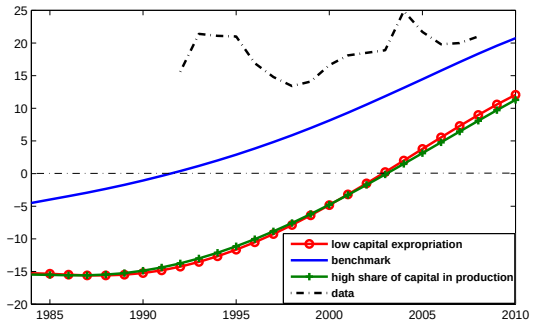


Figure 12: Firms' savings (% GDP) - China

[32]However, this consumption behavior that depends on capital depreciation is not very realistic, as it is too much linked to the capital accumulation of firms. In "reality", lower capital losses for firms would impact household savings through the returns on investments: the latter would be higher, so the returns on domestic bonds too (without credit market frictions). If households could make a real trade-off between foreign and domestic bonds, it would raise their purchases of domestic bonds of private firms (with higher returns). Note that household savings should also be function of other structural elements that are detailed in the literature review, as the quality of pension systems and social insurance, the demographic growth, housing prices, etc. These elements should also drive household savings, and have a larger impact on consumption than the impact of domestic bonds due to lower capital expropriation for example.

5.2.4. Summary

All the results are obtained under the condition of a higher TFP growth in China, determining to a large extent the growth rate of each variable. If the deterministic and permanent TFP growth path in China was not so high, all the imbalances and distortions would be lower. The economic liberalization (privatization), combined with distortions in factor intensiveness created by the misallocation of household savings to SOEs, matter the most to solve the two-way capital flows puzzle (the accumulation of foreign assets while inward FDI are massive). The financial liberalization amplifies the movement in financial capital, while expropriation and moral hazard matter to get the right levels compared to the data for all stylized facts. The other main element is the drop in the consumption share that can also be explained by the financial intermediation that favors SOEs during privatization. Indeed, the sensitivity study shows that without privatization or credit bias to SOEs, the consumption share in China would be constant and high (Figures 9 and 10, panel (g)).

6. Conclusion

This study sheds light on the external and domestic imbalances encountered by China during its economic transition. Indeed, when the public sector does not assist enough the growing private one, in addition to other credit and capital markets frictions, it creates external surpluses and hinders domestic private firms' investment and consumption.

The key element of the capital misallocation is household savings that are driven to SOEs. The growing share of productive private firms becomes credit-constrained and labor-intensive, and thus exports, accumulates profits and savings; the latter are invested abroad through foreign reserves. Financial liberalization, moral hazard and capital expropriation just amplify the effect but are not at the origin. In addition, a larger share of households works in these new labor-intensive firms in which wage growth is hindered by credit constraints, and the returns on household deposits are low to finance SOEs. Thus, the consumption share strongly decreases along the transition in this model. Regarding FDI, they are strongly attracted by high TFP growth combined with lower wages in China. The amounts of inward FDI could have been higher without capital expropriation, moral hazard, and credit constraints along the transition.

To correct the domestic and external imbalances of the Chinese economy, this study highlights the necessity to better allocate savings (to the most productive firms), particularly by correcting distortions in credit costs across private and public sectors.

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8. Appendices

8.1. Appendix A: Dynamics

The model is solved along the balanced growth path, so each variable is computed against A_t, except interest rates and hours worked: $x_t = \frac{X_t}{A_t}$, with $A_t = (1+g_A)A_{t-1} = (1+g_A)^t A_0$. Note that for expatriated firms A_0 is from the home country and g_A is local, so U.S. firms expatriated in China have the following technology $A^*_{f,t} = (1+g_{A_d})^t A_{f,0}$, and Chinese firms expatriated in the U.S. $A^*_{d,t} = (1+g_{A_f})^t A_{d,0}$. Thus, we get the following equations:

Domestic firms (d for private domestic, d^* for private domestic expatriated, S for SOEs):

$$\begin{aligned}\pi_{d,T,t} = \pi_{d,t} + \pi^*_{d,t} + \pi_{S,t} = y_{d,t} + y^*_{d,t} + y_{S,t} + d_{d,t} + d^*_{d,t} + d_{S,t} + IC_d \\ - (1+r_{d,t})(1-\gamma_d)\frac{d_{d,t-1}}{1+g_{A_d}} - (1+r_{d,t})(1-\gamma_S)\frac{d_{S,t-1}}{1+g_{A_S}} - (1+r_{f,t})(1-\gamma_f)\frac{d^*_{d,t-1}}{1+g_{A_f}} \\ - (W_{d,t}N_{d,t} + i_{d,t}) - (W^*_{d,t}N^*_{d,t} + i^*_{d,t}) - (W_{S,t}N_{S,t} + i_{S,t})\end{aligned}$$

$$\begin{aligned} y_{d,t} &= \frac{Y_{d,t}}{A_{d,t}} \\ y^*_{d,t} &= \frac{Y^*_{d,t}}{A^*_{d,t}} \\ y_{S,t} &= \frac{Y_{S,t}}{A_{S,t}} \\ k_{d,t} &= (1-\delta_d)\frac{k_{d,t-1}}{1+g_{A_d}} + i_{d,t} \\ k^*_{d,t} &= (1-\delta_f)\frac{k^*_{d,t-1}}{1+g_{A_f}} + i^*_{d,t} \\ k_{S,t} &= (1-\delta_S)\frac{k_{S,t-1}}{1+g_{A_S}} + i_{S,t} \end{aligned}$$

With financial intermediation:

$$\begin{aligned} d_{d,T,t} = b_{d,t} + fa_{f,t} &= \zeta_d\left(k_{d,t} + k^*_{f,t}\right) + fa_{f,t} \\ d_{f,T,t} = b_{f,t} + fa_{d,t} &= \zeta_f\left(k_{f,t} + k^*_{d,t}\right) + fa_{d,t} \end{aligned}$$

$fa_{d,t}$ is the purchase of foreign assets by the domestic country: it is the sum of the purchase of foreign bonds with domestic household savings ($b^*_{d,t}$) and private firm profits ($\pi_{d,t} + \pi^*_{f,t}$).
The purchase of foreign assets by the foreign country is assumed to be nil: $fa_{f,t} = 0$.

$$\begin{aligned} d_{d,t} &= \left(\frac{k_{d,t}}{k_{d,t} + k^*_{f,t}}\right).d_{d,T,t} \\ d_{S,t} &= b_{S,t} = \zeta_S k_{S,t} \\ d^*_{d,t} &= \left(\frac{k^*_{d,t}}{k_{f,t} + k^*_{d,t}}\right).d_{f,T,t} \end{aligned}$$

with income from foreign assets:

$$IC_d = r_{f,t-1}\left(1-\gamma_f\right)\left[\frac{fa_{d,t}}{1+g_{A_d}} - \frac{\chi_d}{1+\mu_d}\left[\left(fa_{d,t} - \frac{fa_{d,t-1}}{1+g_{A_d}}\right)^{1+\mu_d}\right]\right]$$

Using Bellman equation and the value function $V_{i,t} = \beta_d E_t(V_{t+1}) - \lambda_{d,t}(\pi_{d,T,t})$, we get firms' FOCs:

$$\begin{aligned} (1-\alpha_d)\frac{y_{d,t}}{N_{d,t}} &= W_{d,t} \\ (1-\alpha_d)\frac{y^*_{d,t}}{N^*_{d,t}} &= W^*_{d,t} \\ (1-\alpha_S)\frac{y_{S,t}}{N_{S,t}} &= W_{S,t} \\ E_t\left[\frac{\lambda_{d,t+1}}{\lambda_{d,t}}\left(\alpha_d\frac{y_{d,t+1}}{k_{d,t}} + \frac{1}{1+g_{A_d}}.(1-\delta_d - \zeta_d\left(1+r_{d,t}\right)\left(1-\gamma_d\right))\right) - \left(\frac{1-\zeta_d}{\beta}\right)\right] &= 0 \\ E_t\left[\frac{\lambda_{d,t+1}}{\lambda_{d,t}}\left(\alpha_d\frac{y^*_{d,t+1}}{k^*_{d,t}} + \frac{1}{1+g_{A_f}}.(1-\delta_f - \zeta_f\left(1+r_{f,t}\right)\left(1-\gamma_f\right))\right) - \left(\frac{1-\zeta_f}{\beta}\right)\right] &= 0 \\ E_t\left[\frac{\lambda_{d,t+1}}{\lambda_{d,t}}\left(\alpha_S\frac{y_{S,t+1}}{k_{S,t}} + \frac{1}{1+g_{A_S}}.(1-\delta_S - \zeta_S\left(1+r_{d,t}\right)\left(1-\gamma_S\right))\right) - \left(\frac{1-\zeta_S}{\beta}\right)\right] &= 0 \end{aligned}$$

Foreign firms (f for private foreign, f^* for private foreign expatriated):

$$\begin{aligned} \pi_{f,T,t} = \pi_{f,t} + \pi^*_{f,t} = y_{f,t} + y^*_{f,t} + d_{f,t} + d^*_{f,t} + IC^*_f \\ -\left(1+r_{f,t}\right)\left(1-\gamma_f\right)\frac{d_{f,t-1}}{1+g_{A_f}} - \left(1+r_{d,t}\right)\left(1-\gamma_d\right)\frac{d^*_{f,t-1}}{1+g_{A_d}} - \left(W_{f,t}N_{f,t} + i_{f,t}\right) - \left(W^*_{f,t}N^*_{f,t} + i^*_{f,t}\right) \end{aligned}$$

$$
\begin{aligned}
y_{f,t} &= \frac{Y_{f,t}}{A_{f,t}} \\
y^*_{f,t} &= \frac{Y^*_{f,t}}{A^*_{f,t}} \\
k_{f,t} &= (1-\delta_f)\frac{k_{f,t-1}}{1+g_{A_f}} + i_{f,t} \\
k^*_{f,t} &= (1-\delta_d)\frac{k^*_{f,t-1}}{1+g_{A_d}} + i^*_{f,t}
\end{aligned}
$$

With financial intermediation:

$$
\begin{aligned}
d_{d,T,t} = b_{d,t} + fa_{f,t} &= \zeta_d\left(k_{d,t} + k^*_{f,t}\right) + fa_{f,t} \\
d_{f,T,t} = b_{f,t} + fa_{d,t} &= \zeta_f\left(k_{f,t} + k^*_{d,t}\right) + fa_{d,t}
\end{aligned}
$$

$fa_{f,t}$ is the purchase of foreign assets by the foreign country, which is assumed to be nil: $fa_{f,t} = 0$.

$$
\begin{aligned}
d_{f,t} &= \left(\frac{k_{f,t}}{k_{f,t} + k^*_{d,t}}\right).d_{f,T,t} \\
d^*_{f,t} &= \left(\frac{k^*_{f,t}}{k_{d,t} + k^*_{f,t}}\right).d_{d,T,t}
\end{aligned}
$$

Using Bellman equation and the value function $V_{i,t} = \beta_f E_t(V_{t+1}) - \lambda_{f,t}(\pi_{f,T,t})$, we get firms' FOCs:

$$
\begin{aligned}
(1-\alpha_f)\frac{y_{f,t}}{N_{f,t}} &= W_{f,t} \\
(1-\alpha_f)\frac{y^*_{f,t}}{N^*_{f,t}} &= W^*_{f,t} \\
E_t\left[\frac{\lambda_{f,t+1}}{\lambda_{f,t}}\left(\alpha_f\frac{y_{f,t+1}}{k_{f,t}} + \frac{1}{1+g_{A_f}}.(1-\delta_f-\zeta_f(1+r_{f,t})(1-\gamma_f))\right) - \left(\frac{1-\zeta_f}{\beta}\right)\right] &= 0 \\
E_t\left[\frac{\lambda_{f,t+1}}{\lambda_{f,t}}\left(\alpha_f\frac{y^*_{f,t+1}}{k^*_{f,t}} + \frac{1}{1+g_{A_d}}.(1-\delta_d-\zeta_d(1+r_{d,t})(1-\gamma_d))\right) - \left(\frac{1-\zeta_d}{\beta}\right)\right] &= 0
\end{aligned}
$$

Domestic households:

$$
\begin{aligned}
&c_{d,t} + b_{d,t} + b_{S,t} + \left[b^*_{d,t} + \frac{\chi_d}{1+\mu_d}\left(b^*_{d,t} - \frac{b^*_{d,t-1}}{1+g_{A_d}}\right)^{1+\mu_d}\right] = (1+r_{f,t})(1-\gamma_f)\frac{b^*_{d,t-1}}{1+g_{A_d}} \\
&+ (1+r_{d,t})\left[(1-\gamma_S)\frac{b_{S,t-1}}{1+g_{A_S}} + (1-\gamma_d)\frac{b_{d,t-1}}{1+g_{A_d}}\right] + W_{d,t}N_{d,t} + W^*_{f,t}N^*_{f,t} + W_{S,t}N_{S,t}
\end{aligned}
$$

With $\sigma = 1$ (consistent with deterministic shocks and forced by the balanced growth path), and using Bellman equation and the value function $V_{i,t} = u(c_{d,t}, N_{d,t}, N^*_{f,t}, N_{S,t}) + \beta_d E_t(V_{t+1}) - \lambda_{d,t}(BudgetConstraint_{d,t})$, we get households'

FOCs:

$$\begin{aligned}
c_{d,t}^{-1} &= \lambda_{d,t} \\
N_{d,t}^{\psi} c_{d,t} &= W_{d,t} \\
N_{f,t}^{*\psi} c_{d,t} &= W_{f,t}^{*} \\
N_{S,t}^{\psi} c_{d,t} &= W_{S,t} \\
\lambda_{d,t} &= \beta E_t \left(\lambda_{d,t+1}(1+g_{A_d})\left(1+r_{d,t+1}\right)\left(1-\gamma_d\right)\right) \\
\lambda_{d,t}\left[1+\chi_d\left(b_{d,t}^{*}-\frac{b_{d,t-1}^{*}}{1+g_{A_d}}\right)^{\mu_d}\right] &= \beta E_t \left(\lambda_{d,t+1}(1+g_{A_d})\left(1+r_{f,t+1}\right)\left(1-\gamma_f\right)\right) \\
\left[1+\chi_d\left(b_{d,t}^{*}-\frac{b_{d,t-1}^{*}}{1+g_{A_d}}\right)^{\mu_d}\right] &= \frac{\left(1+r_{f,t+1}\right)\left(1-\gamma_f\right)}{\left(1+r_{d,t+1}\right)\left(1-\gamma_d\right)}
\end{aligned}$$

Combining the latter two equations, we obtain the trade-off between home and foreign bonds:

$$\left[1+\chi_d\left(b_{d,t}^{*}-\frac{b_{d,t-1}^{*}}{1+g_{A_d}}\right)^{\mu_d}\right] = \frac{\left(1+r_{f,t+1}\right)\left(1-\gamma_f\right)}{\left(1+r_{d,t+1}\right)\left(1-\gamma_d\right)}$$

Foreign households:

$$\begin{aligned}
&c_{f,t}+b_{f,t}+\left[b_{f,t}^{*}+\frac{\chi_f}{1+\mu_f}\left(b_{f,t}^{*}-\frac{b_{f,t-1}^{*}}{1+g_{A_f}}\right)^{1+\mu_f}\right] = \left(1+r_{d,t}\right)\left(1-\gamma_d\right)\frac{b_{f,t-1}^{*}}{1+g_{A_f}} \\
&+\left(1+r_{f,t}\right)\left(1-\gamma_f\right)\frac{b_{f,t-1}}{1+g_{A_f}}+W_{f,t}N_{f,t}+W_{d,t}^{*}N_{d,t}^{*}
\end{aligned}$$

With $\sigma = 1$ (consistent with deterministic shocks and forced by the balanced growth path), and using Bellman equation and the value function $V_{i,t} = u(c_{f,t}, N_{f,t}, N_{d,t}^{*}) + \beta_f E_t(V_{t+1}) - \lambda_{d,t}(BudgetConstraint_{f,t})$, we get households' FOCs:

$$\begin{aligned}
c_{f,t}^{-1} &= \lambda_{f,t} \\
N_{f,t}^{\psi} c_{f,t} &= W_{f,t} \\
N_{d,t}^{*\psi} c_{f,t} &= W_{d,t}^{*} \\
\lambda_{f,t} &= \beta E_t \left(\lambda_{f,t+1}(1+g_{A_f})\left(1+r_{f,t+1}\right)\left(1-\gamma_f\right)\right)
\end{aligned}$$

The purchase of foreign assets by the foreign country is assumed to be nil: $b_{f,t}^{*} = 0$.

8.2. Appendix B: Steady-state

-Real interest rates:

$$\begin{aligned} r_d &= \frac{1}{\beta(1-\gamma_d)} - 1 \\ r_f &= \frac{1}{\beta(1-\gamma_f)} - 1 \end{aligned}$$

-Production:

$$\begin{aligned} y_d &= \Upsilon_d^{\frac{\alpha_d}{\alpha_d - 1}} N_d \\ y_{f^*} &= \Upsilon_{f^*}^{\frac{\alpha_f}{\alpha_f - 1}} N_{f^*} \\ y_S &= \Upsilon_S^{\frac{\alpha_S}{\alpha_S - 1}} N_S \\ y_f &= \Upsilon_f^{\frac{\alpha_f}{\alpha_f - 1}} N_f \\ y_{d^*} &= \Upsilon_{d^*}^{\frac{\alpha_d}{\alpha_d - 1}} N_{d^*} \end{aligned}$$

with

$$\begin{aligned} \Upsilon_d &= \frac{1}{\alpha_d}.\left[\frac{\zeta_d(1+r_d)(1-\gamma_d)}{1+g_{Ad}} - \frac{1-\delta_d}{1+g_{Ad}} + \frac{1-\zeta_d}{\beta}\right] \\ \Upsilon_{f^*} &= \frac{1}{\alpha_f}.\left[\frac{\zeta_d(1+r_d)(1-\gamma_d)}{1+g_{Ad}} - \frac{1-\delta_d}{1+g_{Ad}} + \frac{1-\zeta_d}{\beta}\right] \\ \Upsilon_S &= \frac{1}{\alpha_S}.\left[\frac{\zeta_S(1+r_S)(1-\gamma_S)}{1+g_{AS}} - \frac{1-\delta_S}{1+g_{AS}} + \frac{1-\zeta_S}{\beta}\right] \\ \Upsilon_f &= \frac{1}{\alpha_f}.\left[\frac{\zeta_f(1+r_f)(1-\gamma_f)}{1+g_{Af}} - \frac{1-\delta_f}{1+g_{Af}} + \frac{1-\zeta_f}{\beta}\right] \\ \Upsilon_{d^*} &= \frac{1}{\alpha_d}.\left[\frac{\zeta_f(1+r_f)(1-\gamma_f)}{1+g_{Af}} - \frac{1-\delta_f}{1+g_{Af}} + \frac{1-\zeta_f}{\beta}\right] \end{aligned}$$

-Capital:

$$\begin{aligned} k_d &= \Upsilon_d^{\frac{1}{\alpha_d - 1}} N_d \\ k_{f^*} &= \Upsilon_{f^*}^{\frac{1}{\alpha_f - 1}} N_{f^*} \\ k_S &= \Upsilon_S^{\frac{1}{\alpha_S - 1}} N_S \\ k_f &= \Upsilon_f^{\frac{1}{\alpha_f - 1}} N_f \\ k_{d^*} &= \Upsilon_{d^*}^{\frac{1}{\alpha_d - 1}} N_{d^*} \end{aligned}$$

-Investment:

$$\begin{aligned}
i_d &= \Upsilon_d^{\frac{1}{\alpha_d-1}} N_d \left[\frac{g_{Ad}+\delta_d}{1+g_{Ad}}\right] \\
i_{f^*} &= \Upsilon_{f^*}^{\frac{1}{\alpha_f-1}} N_{f^*} \left[\frac{g_{Ad}+\delta_d}{1+g_{Ad}}\right] \\
i_S &= \Upsilon_S^{\frac{1}{\alpha_S-1}} N_S \left[\frac{g_{AS}+\delta_S}{1+g_{AS}}\right] \\
i_f &= \Upsilon_f^{\frac{1}{\alpha_f-1}} N_f \left[\frac{g_{Af}+\delta_f}{1+g_{Af}}\right] \\
i_{d^*} &= \Upsilon_{d^*}^{\frac{1}{\alpha_d-1}} N_{d^*} \left[\frac{g_{Af}+\delta_f}{1+g_{Af}}\right]
\end{aligned}$$

-Wages:

$$\begin{aligned}
W_d &= (1-\alpha_d)\Upsilon_d^{\frac{\alpha_d}{\alpha_d-1}} \\
W_{f^*} &= (1-\alpha_f)\Upsilon_{f^*}^{\frac{\alpha_f}{\alpha_f-1}} \\
W_S &= (1-\alpha_S)\Upsilon_S^{\frac{\alpha_S}{\alpha_S-1}} \\
W_f &= (1-\alpha_f)\Upsilon_f^{\frac{\alpha_f}{\alpha_f-1}} \\
W_{d^*} &= (1-\alpha_d)\Upsilon_{d^*}^{\frac{\alpha_d}{\alpha_d-1}}
\end{aligned}$$

-Labor supply:

$$\begin{aligned}
N_d &= \Omega_d N_{f^*} = \frac{1-\eta_{Soe}-\omega_{in}}{\omega_{in}}. \left[\frac{(1-\alpha_d)\Upsilon_d^{\frac{\alpha_d}{\alpha_d-1}}}{(1-\alpha_f)\Upsilon_{f*}^{\frac{\alpha_f}{\alpha_f-1}}}\right]^{\frac{1}{\psi_d}} N_{f^*} \\
N_S &= \Omega_S N_{f^*} = \frac{\eta_{Soe}}{\omega_{in}}. \left[\frac{(1-\alpha_S)\Upsilon_S^{\frac{\alpha_S}{\alpha_S-1}}}{(1-\alpha_f)\Upsilon_{f*}^{\frac{\alpha_f}{\alpha_f-1}}}\right]^{\frac{1}{\psi_d}} N_{f^*} \\
N_f &= \Omega_f N_{d^*} = \frac{1-\omega_{out}}{\omega_{out}}. \left[\frac{(1-\alpha_f)\Upsilon_f^{\frac{\alpha_f}{\alpha_f-1}}}{(1-\alpha_d)\Upsilon_{d*}^{\frac{\alpha_d}{\alpha_d-1}}}\right]^{\frac{1}{\psi_f}} N_{d^*} \\
N_{f^*} &= \varrho_Y.\omega_{in}^{\frac{\psi_d}{\psi_d+\sigma_d}}. \left[(1-\alpha_f)\Upsilon_{f*}^{\frac{\alpha_f}{\alpha_f-1}}\right]^{\frac{1}{\psi_d+\sigma_d}} .[\Theta_d+\Theta_{f^*}+\Theta_S]^{\frac{-\sigma_d}{\psi_d+\sigma_d}} \\
N_{d^*} &= (1-\varrho_Y).\omega_{out}^{\frac{\psi_f}{\psi_f+\sigma_f}}. \left[(1-\alpha_d)\Upsilon_{d*}^{\frac{\alpha_d}{\alpha_d-1}}\right]^{\frac{1}{\psi_f+\sigma_f}} .[\Theta_f+\Theta_{d^*}]^{\frac{-\sigma_f}{\psi_f+\sigma_f}}
\end{aligned}$$

with

$$\begin{aligned}
\Theta_d &= \Upsilon_d^{\frac{1}{\alpha_d - 1}} \Omega_d \left[\Upsilon_d - \left[\frac{g_{Ad} + \delta_d}{1 + g_{Ad}} \right] \right] \\
\Theta_{f^*} &= \Upsilon_{f^*}^{\frac{1}{\alpha_f - 1}} \left[\Upsilon_{f^*} - \left[\frac{g_{Ad} + \delta_d}{1 + g_{Ad}} \right] \right] \\
\Theta_S &= \Upsilon_S^{\frac{1}{\alpha_S - 1}} \Omega_S \left[\Upsilon_S - \left[\frac{g_{AS} + \delta_S}{1 + g_{AS}} \right] \right] \\
\Theta_f &= \Upsilon_f^{\frac{1}{\alpha_f - 1}} \Omega_f \left[\Upsilon_f - \left[\frac{g_{Af} + \delta_f}{1 + g_{Af}} \right] \right] \\
\Theta_{d^*} &= \Upsilon_{d^*}^{\frac{1}{\alpha_d - 1}} \left[\Upsilon_{d^*} - \left[\frac{g_{Af} + \delta_f}{1 + g_{Af}} \right] \right]
\end{aligned}$$

-Consumption:

$$\begin{aligned}
c_d &= \Upsilon_d^{\frac{1}{\alpha_d - 1}} N_d \left[\Upsilon_d - \left[\frac{g_{Ad} + \delta_d}{1 + g_{Ad}} \right] \right] + \Upsilon_{f^*}^{\frac{1}{\alpha_f - 1}} N_{f^*} \left[\Upsilon_{f^*} - \left[\frac{g_{Ad} + \delta_d}{1 + g_{Ad}} \right] \right] + \Upsilon_S^{\frac{1}{\alpha_S - 1}} N_S \left[\Upsilon_S - \left[\frac{g_{AS} + \delta_S}{1 + g_{AS}} \right] \right] \\
c_f &= \Upsilon_f^{\frac{1}{\alpha_f - 1}} N_f \left[\Upsilon_f - \left[\frac{g_{Af} + \delta_f}{1 + g_{Af}} \right] \right] + \Upsilon_{d^*}^{\frac{1}{\alpha_d - 1}} N_{d^*} \left[\Upsilon_{d^*} - \left[\frac{g_{Af} + \delta_f}{1 + g_{Af}} \right] \right]
\end{aligned}$$

8.3. Appendix C: Additional figures

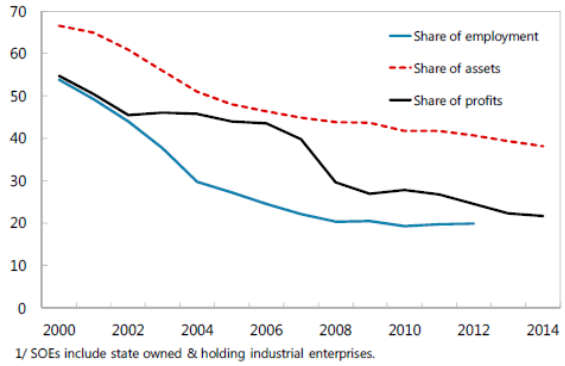

Figure 13: Share of SOEs in the *industry* (% total, from 2000 to 2014), China - Source: IMF Country Report No. 15/234.

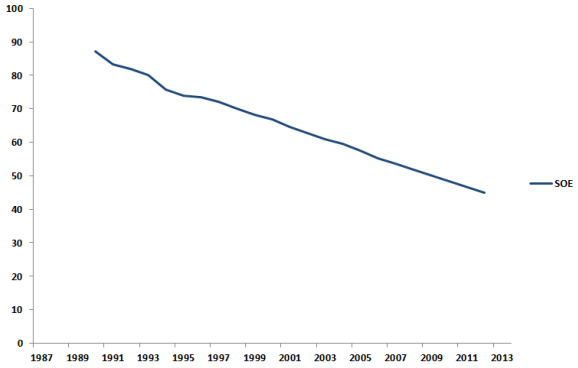

Figure 14: Share of SOEs in *total employment* (%, from 1990 to 2012), China - Source: China Statistical Yearbook (CSY).

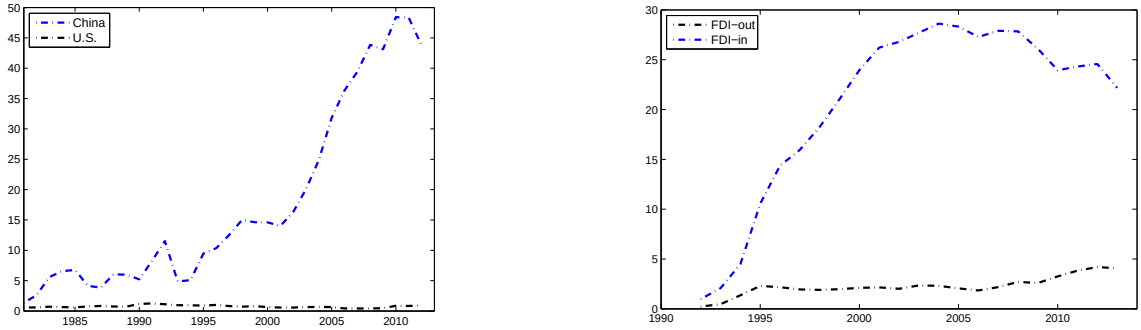

Figure 15: Foreign assets and inward/outward FDI (China - % GDP)
Sources: IMF and UNCTAD databases

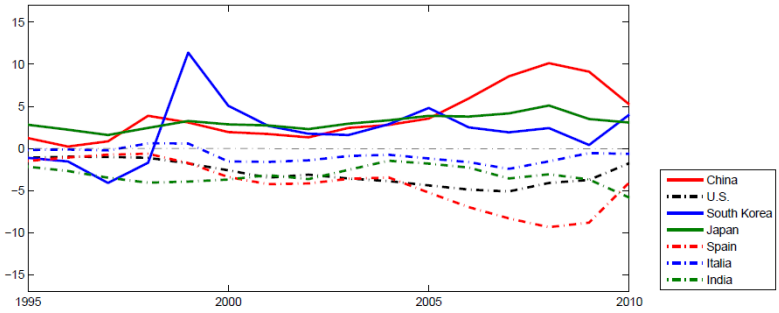

Figure 16: Current accounts (% GDP)
Source: IMF database

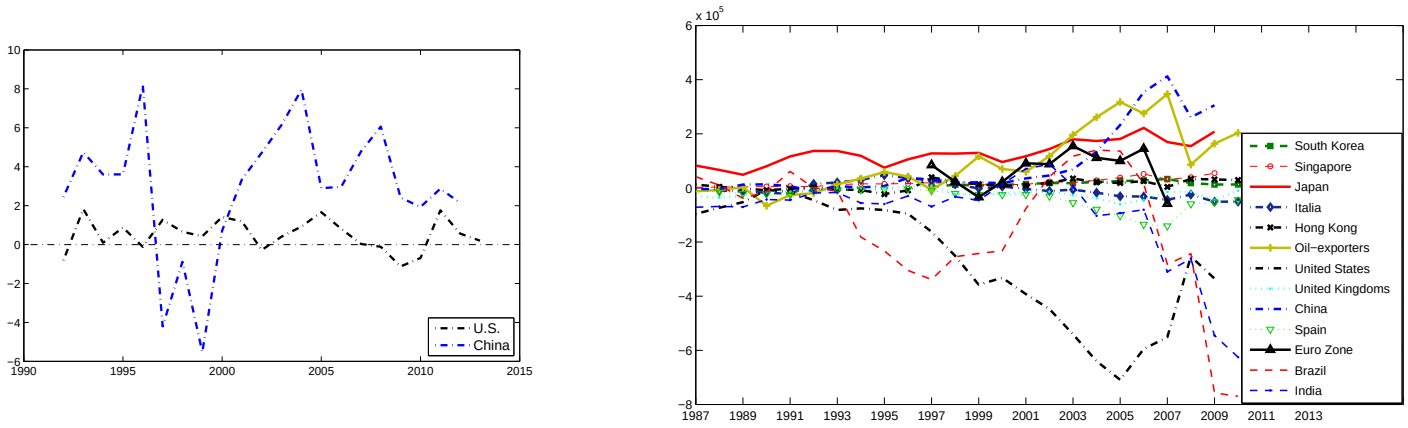

Figure 17: TFP growth (China and U.S., % GDP) and current accounts[33](\$U.S. Millions)
Sources: World Bank and IMF databases

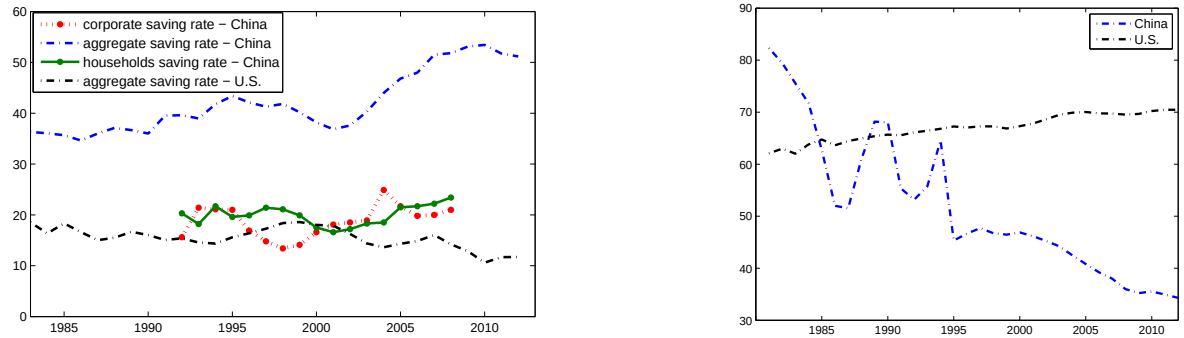

Figure 18: Saving rates and consumption share (China and U.S. - % GDP)
Sources: World Bank and IMF databases

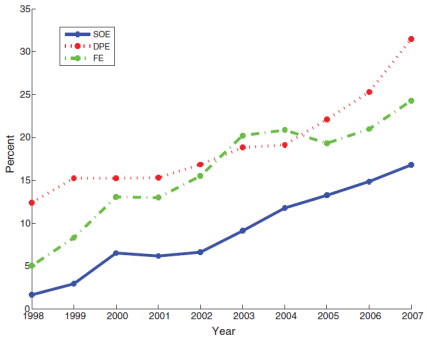

Figure 19: Total profits over net value of fixed assets - *Source:* Song et al. (2011) (CSY, various issues)
DPE: domestic private enterprises; FE: foreign enterprises

[33]In this figure, current accounts are not presented relative to GDP because some countries, such as Singapore and Hong Kong, have large amounts of financial transactions relative to domestic production (which leads to current accounts above 20%). For current accounts in % of GDP, see Figure 16.

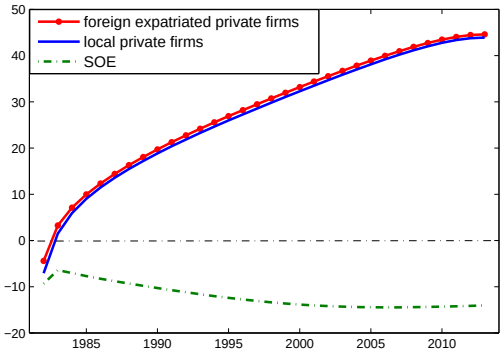

Figure 20: Firms' profits[34](% GDP of each firm) - China

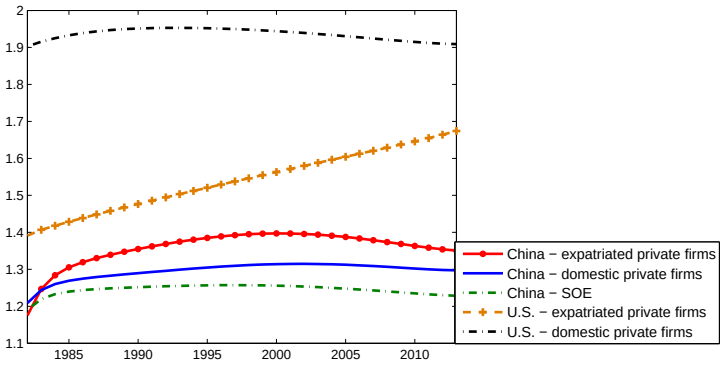

Figure 21: Wages (*along the balanced growth path*)

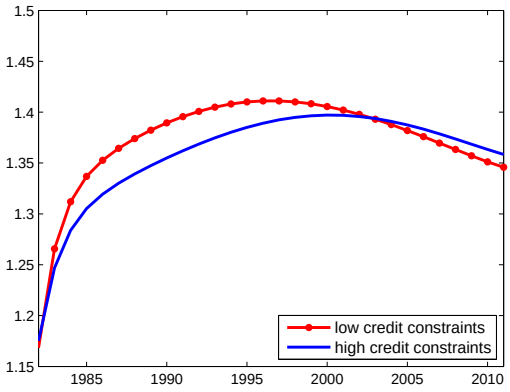

Figure 22: Wages in foreign expatriated firms under high and low credit constraints - China

[34]SOEs' profits, and thus savings, are lower than those of private firms (Huang, 2011) and negative. This is due to the calibration that underestimates the TFP growth of a share of the population of SOEs during the second part of the transition. The financial losses of some SOEs are described in the literature (Aglietta and Landry, 2007; Zhou, 2013; Borst and Lardy, 2015).