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Financial capital flows, FDI, China's transition, privatization, global imbalances, consumption, credit and capital markets frictions, TFP growth.

JEL codes:

E20, F21, F32, O16, P30

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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 many emerging countries also face a major privatization during their economic transition (see Figure 4 for China). Moreover, the distinction between financial capital flows (portfolio investments) and fixed capital flows (FDI) is crucial but rare in the literature (particularly in dynamic general growth equilibrium models). Indeed, some emerging (especially Asian) economies experience large FDI inflows while they accumulate foreign assets, which creates large net external positions (see Figures 1 and 2).

The main contribution of this paper is to explain both the allocation puzzle of capital flows and the drop in consumption 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 imbalances among a variety of frictions. Indeed, capital expropriation, moral hazard, capital controls, or capital share 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 inflows and outflows 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) accumulating savings, which are invested in foreign assets whereas FDI is attracted.¹

Regarding the drop in consumption in China, it is mainly explained by the capital misallocation to SOEs in this framework. Indeed, it raises households' time spent at work with the increase in cheap labor demand due to a rising share of labor-intensive firms. Then, the other explanation in this model is that a large part of household savings must be invested in SOE bonds with low returns, preventing any trade-off between all of the assets in the economy.² All of the elements described above are structural issues and could be experienced by countries with an economic transition based on an "unbalanced" privatization.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 during privatization over the last 30 years. Indeed, under high TFP growth (Figure 2), China experienced a large current account surplus at the end of the transition (up to 10 % of GDP in 2007, Figure 2), while 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 both for households and firms (Figure 3). Thus, foreign assets were accumulated (foreign assets over GDP increased to 50 %, Figure 1) whereas FDI entered

¹Actually, external surpluses are mostly invested in foreign assets through sovereign wealth funds, which are not considered in the model.

²However, to keep a simple model, some determinants of household savings are not considered (for example, the bad quality of social insurance, pension system, property rights protection, rising expenditures on housing, education, ... (see Horioka and Wan (2007), Chamon and Prasad (2010), and Wei and Zhang (2011), among others)).

³In this paper, an "unbalanced" privatization corresponds to the current situation of China's credit market (it is also the case in some Eastern Europe countries). Indeed, while seeing their share decreasing, public banks keep a strong influence on the credit market, benefiting SOEs to the detriment of an increasing share of private firms.

massively in the country. Consumption was surprisingly decreasing all along the transition in China (Figure 3), and private firms' investments were hindered (even if they could partly overcome it through shadow banking, see Tsai (2002), Krugman (2011), and Funke, Mihaylovski, and Zhu (2015)).

This paper is close to Song, Storesletten, and Zilibotti (2011), particularly for the role of SOEs and credit constraints. However, this theoretical framework is different; there is no OLG structure as in Song et al. but a dynamic general equilibrium with TFP growth which distinguishes between FDI and other financial flows, allows for additional assumptions (capital expropriation, moral hazard and capital controls), and explains the drop in Chinese consumption. Similar to Ju and Wei (2010), the paper models the two-way capital flows, but in a dynamic framework allowing for richer effects. The impact of moral hazard and the lack of property rights protection on the investments rate is highlighted in this model (as in the work of Ju and Wei): it raises savings rates and the accumulation of foreign assets. However, if some assumptions of Ju and Wei are relevant and considered in the model, the pattern of two-way capital flows is here mostly driven by the economic liberalization (the privatization of firms in China) under heterogeneous credit frictions. In this model, the allocation of household savings to SOEs (and not to the increasing share of private firms) solves both the allocation puzzle of capital flows and the drop in consumption in China. Then, the role of the financial liberalization in the model is not as important as it is in Benhima (2013a). By highlighting the role of firms' structure and factor intensiveness, this work is also close to Jin (2012), where there is a composition effect (capital flowing toward where it is intensive after a labor force/productivity shock) in addition to a convergence effect (capital flowing toward where it is scarce). This study also adds to the existing literature on the Chinese decrease in consumption, by giving different explanations (valid in this framework). Indeed, here the misallocation of capital to SOEs fully explains the drop in Chinese consumption: households have low returns on SOE bonds and spend more time working in the new labor-intensive firms at low wages. The literature, however, focuses on the poor quality of social insurance and the pension system, on the housing bubble, and even on the consequences of the one-child policy and demographic trends (see Horioka and Wan (2007), Chamon and Prasad (2010), and Wei and Zhang (2011), among others). Finally, it sheds light on the risks of capital misallocation and external imbalances when bank privatization does not completely assist firm privatization. Thus, this paper furthers the literature on the effects of privatization in developing countries (Megginson and Netter (2001), Boyreau-Debray (2003), Boyreau-Debray and Wei (2005), and Estrin, Hanousek, and Svejnar (2009), among others).

What are the main elements of the model and the basic mechanisms? The framework is a simple two-country dynamic general equilibrium growth model. There are different types of firms: State-Owned Enterprises (SOEs), private domestic and expatriate firms (from the rest of the world, here the U.S.). An economic liberalization is considered (firm privatization with a decreasing share of SOEs along the transition) and also a financial liberalization (less capital controls across time). There are two types of capital flows: FDI (firms can choose whether to invest abroad) and financial capital flows (bonds financing firms). In the domestic country (China), public banks drive household savings to SOEs to the detriment of private firms despite their high TFP growth: SOEs become capital intensive and private

⁴In this figure current accounts are not presented relatively to GDP because of some countries, such as Singapore and Hong-Kong, which have large amounts of financial transactions relative to domestic production; therefore, it involves huge current accounts in % GDP (close to 100). For current accounts in GDP, see Figure 16 in Appendix.

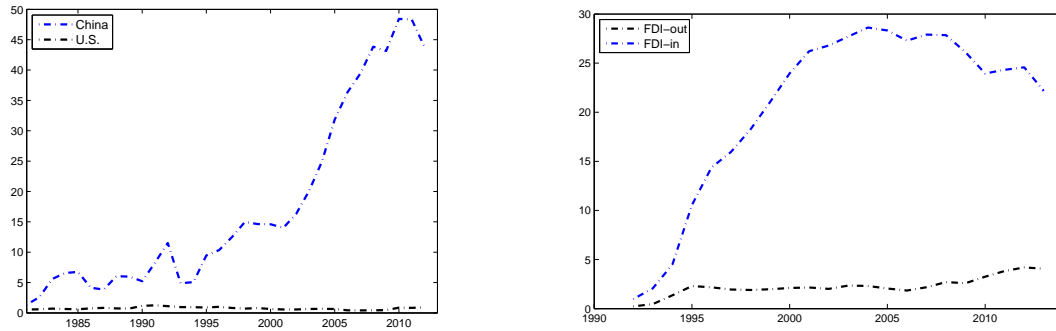


Figure 1: Foreign assets and FDI-in/out (China - % GDP)
Sources: IMF and UNCTAD databases

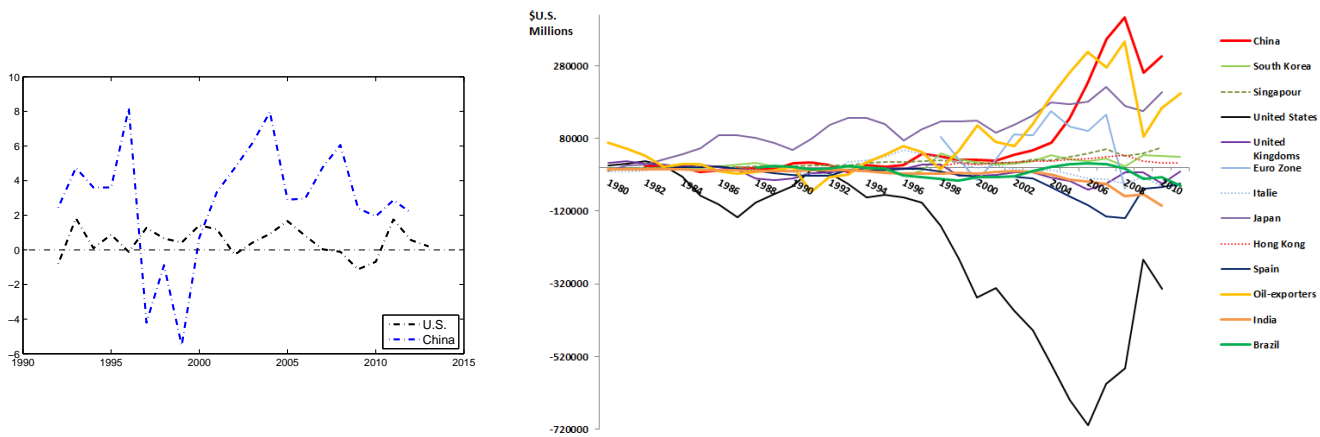


Figure 2: TFP growth (China and U.S., % GDP) and current accounts⁴
Sources: World Bank and IMF databases

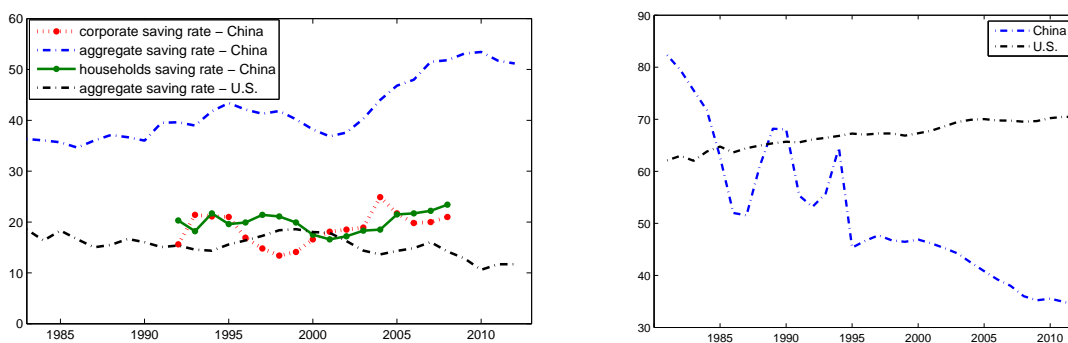


Figure 3: Saving rates and consumption (China and U.S. - % GDP)
Sources: World Bank and IMF databases

firms labor intensive. Combined with other frictions such as moral hazard and capital expropriation, capital misallocation and external surpluses are created. Indeed, as a first simple explanation before

going into details in the model section, low wages and high TFP growth cause FDI to enter the country; but public financial intermediation and frictions on credit and capital markets hinder investment (for private firms and without considering any shadow banking) and consumption. Thus, firms' profits and household savings are invested abroad through financial assets. As for consumption, in this framework, the privatization of firms (households spend more time at work at low wages) and the low returns on deposits (with public financial intermediation) increase household savings which are mostly invested in SOEs, but also in private firms or abroad. Adding realistic assumptions and specific calibration (see the model and calibration sections), the model replicates qualitatively and quantitatively the patterns of an economy in transition (here, China), affected by structural issues in its dynamic of privatization. The main assumptions of the model are detailed in the model section.

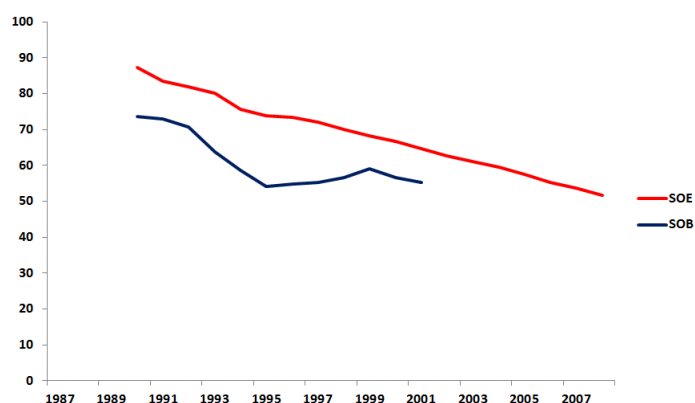


Figure 4: The share of employment in SOEs - the share of credit and deposits in SOBs (China - %
Sources: China Statistical Yearbook (CSY) and Finance and Banking Yearbook (FBY))

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

2 Literature review

A main explanation emerged from the debate surrounding international global imbalances (particularly between the U.S. and Asian emerging countries). High growth in emerging countries and structural imperfections, such as deficient institutions, governance, credit markets, and social insurance, ... 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 financial depth in emerging countries, savings flow toward countries with riskless financial markets (Caballero, Farhi, and Gourinchas (2008b), Mendoza, Quadrini, and Rios-Rull (2009)). It is the “global saving glut” of Bernanke (2005).⁵

⁵Caballero et al. (2008a) extend this “global saving glut” by giving a possible explanation of recent asset bubbles. The high assets demand has primarily come from emerging countries for the past two decades, first creating an asset bubble in East Asia in the 1990s. After its collapse, the high assets demand moved to the United States through Nasdaq, then was extended to the credit and housing markets. The 2008 financial crisis brought the bubble to the commodities markets; then, it came back to U.S markets when commodities demand dropped (with the world economy collapse).

This element is also highlighted in the empirical work of Gourinchas and Jeanne (2013): they observe (with a disaggregation of capital flows) that the allocation puzzle is a savings puzzle related to growth (see also Coeurdacier, Guibaud, and Jin (2013)), productivity, and the accumulation of international reserves. Emerging economies with high (resp., low) productivity growth tend to export (resp., import) capital.⁶

A relevant point is that, in the literature, the allocation puzzle involves aggregate net foreign assets (both public and private). However, in the empirical work of Alfaro, Kalemli-Ozcan and Volosovych (2014), sovereign-to-sovereign transactions can fully account for net capital outflows from emerging countries and global imbalances. It is in line with the theoretical framework of Aguiar and Amador (2011) where in a variant of the open economy neoclassical growth model emphasizing political economy and contracting frictions, the allocation puzzle is driven by the net foreign asset position of the public sector. The surge in financial capital flows from emerging to developed countries has many consequences, such as the induced external surpluses and deficits. These risks and consequences are well detailed in Blanchard and Milesi-Ferretti (2009) and are not reduced to the usual highlighted case of the U.S..⁷

One weak point of this explanation is the non-differentiation between FDI and financial capital. Indeed, as described in the introduction, although financial capital is flowing out of Asian countries (especially China), the latter observe large FDI entries (see Figures 1 and 2). It is incorporated in the study of Ju and Wei (2010) through a static framework from a Heckscher-Ohlin-Samuelson two factors - two countries model. Here, the distinction is performed in a dynamic general equilibrium growth model, in particular allowing for the impact of TFP growth. Without FDI, Caballero et al. (2008b) provide an excellent theoretical explanation of the phenomenon, but only from a macro and financial perspective. The second weak point in the related literature is the lack of specification of all structural imperfections hindering investment (creating excessive saving rates in private firms), particularly in China, and channeling financial capital abroad when it is associated to a deficient domestic financial system. Regarding this point, the work of Song, Storesletten, and Zilibotti (2011) is the most complete, and it has an excellent fit to the data. Its OLG neoclassical model with population and TFP growth has financial and contractual imperfections and distinguishes private and State-owned enterprises (SOE).⁸ This more micro view of Chinese transition and its manufacturing sector emphasizes, among others, the role of heterogeneous credit constraints between SOEs (a better access to finance) and private firms (with tightened credit constraints). The latter, more productive, become labor intensive and accumulate profits, which are saved abroad. However, the work of Song et al. (2011) does not model FDI in/outflows paths or the drop in consumption and without the impacts of other frictions such as moral hazard, capital controls, and capital expropriation. These latter are included in Ju and Wei's model and are the main drivers of

⁶This allocation puzzle is very close to the Lucas Paradox but remains different. The Lucas Paradox emphasizes that the volume of capital flows to developing countries is abnormally small compared to the theory. However, according to Gourinchas and Jeanne (2013), the allocation puzzle concerns the allocation of capital inflows across developing countries and how this allocation is correlated with cross-country differences in productivity growth (also not consistent with the theory).

⁷The surge in financial capital flows to the U.S. is *one of the* elements enhancing the massive U.S. deficit and lowering global real interest rates. Thus, there is a high share of U.S. assets in portfolios from reserves accumulation in emerging countries (particularly in China).

⁸As in this work, SOEs have a crucial role because they represented 85% of the employment share in China in the beginning of 1990s, whereas only 40% in 2010 (Sources: Chinese Statistical Yearbook (CSY) and Chinese Labor Statistical Yearbook (CLSY)).

financial capital and FDI paths.⁹ Here, these elements largely enhance capital flows and savings patterns but are not the key elements, which are the industrial structure and credit market frictions (as in Song et al. (2011) and Jin (2012)). The Chinese manufacturing sector has a decreasing (resp., increasing) share of more financed SOEs (resp., credit constrained private firms), and it leads to a surge in the proportion of labor-intensive firms all along the transition. Added to a lower share of capital in production in all Chinese firms, the U.S. production is widely more capital intensive and receives massive financial capital amounts. As in this paper, Jin (2012) highlights how factor proportion can hinge on international capital flows. Indeed, the author describes a new theoretical framework (consistent with the data) where capital flows toward countries becoming more specialized in capital-intensive sectors. This effect, called the “composition effect”, interacts with the standard “convergence effect”, by which capital flows toward countries with a lower capital-labor ratio (after a labor force/productivity shock). Global imbalances are clearly in a context dominated by the first effect: here, the country with positive labor force/productivity shock and credit constraints on private firms, China, observes financial capital outflows to the U.S. (having more capital intensive firms). Regarding credit market frictions, its heavy impact on global imbalances is also well studied in Martin and Taddei (2013): a friction such as limited pledgeability tends to constrain credit and reduce capital inflows, whereas adverse selection may do the opposite (expand credit and increase capital inflows). It is also the case in this work; moreover, credit constraints and moral hazard interact with each other (one enhancing the impact of the other), also as in Martin and Taddei (2013). In Martin and Ventura (2012), a higher financial development in emerging countries could have ambiguous effects. It is also the conclusion here: although domestic investment rises if credit constraints are relaxed, the following capital accumulation increases wages and reduces the profitability of unproductive firms. Some of them can fail. Indeed, the increasing wages shorten capital inflows and investment in these unproductive firms. With this mechanism, reforms improving financial development in emerging Asia (as it is often argued) would not be the best solution to reduce global imbalances.¹⁰

Although goods are traded across countries in this paper, the interaction between trade theory and capital flows is not the main focus. Antras and Caballero (2009) and Jin (2012) further this approach.¹¹ The distinction between short and long-term projects is also an element impacting financial capital flows, especially coming from corporate savings in emerging countries. As a matter of fact, in Benhima (2013a), under financial autarky there is overinvestment in short-term projects and underinvestment in long-term projects (not secured because of credit constraints). This capital misallocation is reduced under financial integration: the access to cheaper assets abroad enables more investment in long-term projects.¹² Here, financial liberalization and capital controls have clearly a poorer effect. Factor intensities and structural

⁹For capital expropriation, it is the introduction of property rights protection, dissociated from the financial sector (which is close to the empirical work of Acemoglu and Johnson (2005)). Moral hazard is included in a framework derived and simplified from Holmstrom and Tirole (1997), but without credit constraints.

¹⁰This conclusion is more precise with a distinction between FDI and financial capital flows; see the sensitivity part in section 5.

¹¹The theoretical study of Antras and Caballero (2009) explains how net capital inflows raise with a deeper trade integration, implying the set up of protectionism in order to rebalance capital flows at a global level. They demonstrate it first by isolating from trade the effects of heterogeneity in financial development on capital flows, second by introducing Heckscher-Ohlin determinants of international trade.

¹²According to this theoretical study, financial integration reallocates capital in the long-run (through cheaper financial assets), leading to capital outflows, current account surpluses, and to a growth in TFP.

imperfections on capital and credit markets are the foundations of Chinese foreign surpluses. Regarding credit market imperfections, one main reason is the way public banks operate: they directly pump household savings through low deposit rates to finance SOEs. Hence higher credit costs for the funding of private firms (Aglietta and Bai (2012)). If households could completely trade-off between domestic (private and SOE) and foreign bonds, even in a non-perfect complete market, a better capital allocation would be done.¹³

This study gives new explanations regarding the Chinese decrease in consumption. The existing literature primarily highlights the elements creating precautionary savings: increasing expenditures on housing, education, health care (Chamon and Prasad (2010)), inflation, the bad quality of pension system, studies under the Life-Cycle Hypothesis (Modigliani and Cao (2004) and Horioka and Wan (2007)), or even the consequences of the one-child policy and the sex ratio (Wei and Zhang (2011)). Here the privatization of firms raises the time households spend working at low wages. In addition to the low returns on deposits with public financial intermediation, and to the financial liberalization, household savings rise and are invested either in SOEs or abroad.

Finally, this study sheds light on the risks of capital misallocation and external imbalances when bank privatization doesn't completely assist firm privatization. Boyreau-Debray (2003) and Boyreau-Debray and Wei (2005) explain the situation of Chinese credit market where public banks keep a strong influence, driving capital to SOEs to the detriment of an increasing share of private firms. Estrin, Hanousek, and Svejnar (2009) summarize the different studies analyzing the effects of privatization on efficiency, profitability, revenues, growth, TFP, and other indicators, in the post-communist (transition) economies and China. They find that although the effect of privatization is mostly positive in Central Europe, it remains ambiguous in many studies on China; studies also summarized in Megginson and Netter (2001).

3 A two-country 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 (the main country under transition and privatizing) and the foreign country is the United States. Each country has households and firms. Households work, consume and save; their savings finance the investments of domestic and foreign firms (the first part of financial capital flows).¹⁴ Firms accumulate capital and invest a share of their capital abroad; these shares of investments are 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 but have better access to credit (public banks relax credit constraints for SOEs, making them capital intensive whereas private firms remain labor intensive). An economic liberalization (privatization of firms in China) is set through an exogenous decreasing share of employment in SOEs. In addition,

¹³Indeed, returns on investments are higher in private firms. If households could buy private firms' bonds with higher returns, a wealth effect would reduce their incentive to buy foreign bonds; thus, it would increase consumption.

¹⁴Regarding the funding of foreign firms by Chinese savings, it is actually mostly conducted by sovereign wealth funds, but it is not the main focus here. In the model this step is skipped and it is assumed that household and corporate savings directly finance foreign firms (and of course domestic ones).

financial frictions of two types are considered. First, a ratio of defaulting loans (moral hazard) reduces returns on bonds. Second, restrictions to capital flows are modeled in the form of trade costs on 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 modeled as a potentially higher depreciation rate of capital. A key assumption makes firms accumulate savings with profits and invest them abroad (the second part of financial capital flows).¹⁵ Finally, the model is focused on real factors and abstracts from nominal rigidities to keep a simple framework, 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.¹⁶ This set of frictions and assumptions under privatization affects savings and investments, so financial capital flows and FDI. The model demonstrates that a realistic calibration exercise fully solves the allocation puzzle of capital flows and the drop in consumption in China, and matches to a large extent the data for the stylized facts described in the introduction.

3.1 Households

Domestic households maximize a welfare index:

$$Max E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_{d,t}^{1-\sigma}}{1-\sigma} - \Phi \frac{N_{d,t}^{1+\psi} + N_{f,t}^{*1+\psi}}{1+\psi} \right), \quad (1)$$

subject to the budget constraint:

$$\begin{aligned} C_{d,t} + B_{d,t} + \left[B_{d,t}^* + \frac{\chi_d}{1+\mu_d} (B_{d,t}^* - B_{d,t-1}^*)^{1+\mu_d} \right] &= (1+r_{f,t})(1-\gamma_f) B_{d,t-1}^* \\ + (1+r_{d,t})(1-\gamma_d) B_{d,t-1} + W_{d,t} N_{d,t} + W_{f,t}^* N_{f,t}^* & \end{aligned} \quad (2)$$

In Equation (2) β is the discount rate, ψ the inverse of the Frisch elasticity of labor supply, and σ the elasticity of intertemporal substitution. $N_{d,t}$ ($N_{f,t}^*$) represents hours of work supplied by domestic households in the domestic firms (foreign expatriated firms; see details in the firms' subsection), and $C_{d,t}$ consumption.

Households' incomes ($W_{d,t} N_{d,t}$ from domestic firm, $W_{f,t}^* N_{f,t}^*$ from foreign expatriated firms) are partly consumed in a single good and saved utilizing bonds. There are two types of bonds issued by firms of countries d and f , so households can choose between domestic and foreign bonds $B_{d/f,t}$. It is assumed that bonds are the only tradable financial assets across countries. Firms are credit constrained and borrow utilizing household savings. In accordance with the main literature (particularly Song et al. (2011)), it is considered that financial markets are incomplete. In Equation (2), $r_{d/f,t}$ are domestic and foreign

¹⁵This assumption is realistic, see Huang (2011) and Benhima (2013a) in particular but also Caballero et al. (2008) and Song et al. (2011), among others. Relying on data, Song et al. (2011) explain that firms' savings are invested abroad. In Benhima's paper, firms finance their future projects with the returns on foreign assets. It is encouraged by capital controls that affect firms less than households (indeed, the latter are almost constrained to invest their savings domestically in SOEs (creating distortions in credit interest rate, see Aglietta and Bai (2012))). Again, and like household savings, it might be highlighted that corporate savings are in reality often invested on foreign assets through sovereign wealth funds, but it is not the main focus here.

¹⁶See the results section for the approximation of the real exchange rate.

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. The model allows for different default rates between the two economies. Various degrees of financial integration can be considered with varying trading costs on bonds purchases $\frac{\chi_d}{1+\mu} (B_{d,t}^* - B_{d,t-1}^*)^{1+\mu}$. These costs are a proxy for capital controls. Parameter χ_d controls the magnitude of costs and μ their curvature.¹⁷ Note that trading costs are based on new bonds purchases at time t and not on the divergence from the steady state.¹⁸

First ordinary conditions are:

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

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

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

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

(3) and (4) are households' labor supply to firms. For simplicity, the labor market is modeled as competitive and frictionless because such frictions would only change the speed of reallocation and the increase in wages, but not the qualitative behavior of the variables.¹⁹ Equation (5) is the usual Euler equation. The *ex-ante* trade-off between domestic and foreign bonds is obtained combining Equations (5) and (6) (*ex-post*, once the amount of domestic bonds is fixed by public financial intermediation through firms' credit constraints; as explained in the next section).

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

Chinese households save (resp., become indebted to the U.S.) when returns on foreign bonds are higher (resp., lower) than those on domestic bonds:

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

¹⁷Chinese 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. According to Xiao and Kimball (2006) and the *Annual Report of Exchange Arrangements and Exchange Restrictions* (AREAER), many subcategories of capital account transactions are subject to taxes and limited amounts since 1990: capital market securities, money market instruments, collective investment securities, derivatives and other instruments, commercial credits, financial credits, guarantee sureties and financial backup securities, direct investment, liquidation of direct investment transactions, real estate transactions, personal capital movements, provisions specific to commercial banks and other credit institutions, provisions specific to institutional investors, and dual exchange rate arrangements.

¹⁸It is not innocuous with respect to the steady state. It would be a problem with stochastic shocks, as the steady state would not be unique with such trading costs (trading costs should be: $\frac{\chi_d}{1+\mu} (B_{d,t}^* - \bar{B}_d^*)^{1+\mu}$). However, deterministic simulations are conducted, so it is not a crucial issue.

¹⁹In reality there are important frictions on the Chinese labor market (Zuo and Wang (1999) explain that despite the huge flow of rural migrants to cities that followed reforms, the access of rural migrants to urban labor markets is selective (Hukou system)).

As explained at the beginning of the model section, it is not impacted by nominal rigidities and exchange rate issues.

Foreign households solve the same problem with the additional constraint that they do not buy foreign bonds ($B_{f,t}^* = 0$).²⁰

The list of all variables is in Table 1.

3.2 Firms

The domestic country (China) has a population of firms comprising private domestic and foreign firms and SOEs. The foreign country (here, the U.S.) only has private domestic and foreign firms. For clarification and to alleviate equations, SOEs will be introduced in the fourth subsection.

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

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

with

$$\begin{aligned} \pi_{d,T,t} = \pi_{d,t} + \pi_{d,t}^* &= Y_{d,t} + Y_{d,t}^* + D_{d,t} - (1 + r_{d,t}) (1 - \gamma_d) D_{d,t-1} + D_{d,t}^* \\ &- (1 + r_{f,t}) (1 - \gamma_f) D_{d,t-1}^* - (W_{d,t} N_{d,t} + I_{d,t}) - (W_{d,t}^* N_{d,t}^* + I_{d,t}^*) \end{aligned} \quad (9)$$

Production combines labor and capital through Cobb-Douglas technology, with capital share α and labor share $1 - \alpha$. Firms operate in both countries. A share of its capital is expatriate; it is equivalent to invest in the foreign country through FDI. So for domestic firms, $\pi_{d,T,t}$ is their total profits, and $\pi_{d,t}$ ($\pi_{d,t}^*$) profits of the capital invested domestically (abroad). When expatriated, firms have their national initial level of TFP and capital share. However, they benefit from local TFP growth, labor force, and funding.²¹ Production functions are:

$$Y_{d,t} = A_{d,t} \cdot K_{d,t-1}^{\alpha} N_{d,t}^{1-\alpha} \quad (10)$$

$$Y_{d,t}^* = A_{d,t}^* \cdot K_{d^*,t-1}^{\alpha} N_{d^*,t}^{1-\alpha} \quad (11)$$

where $Y_{d,t}$ is the production of a domestic firm locally and $Y_{d,t}^*$ the production of a domestic firm abroad. The technology parameter A_t grows at an exogenous rate g_A : $A_t = (1 + g_A) A_{t-1} = (1 + g_A)^t A_0$. As described above, A_0 of expatriated firms is national ($A_{d,0}$) and g_A local (g_{A_f}). Of course, it is assumed that $g_{A_d} > g_{A_f}$, to have a larger TFP growth in China than in the U.S. (for private firms). The model is solved along the balanced growth path, so each variable is computed against A_t , except interest rates

²⁰Indeed, financial investments from United States to China are negligible compared to the opposite flows (foreign liabilities in China go up to 4% of GDP during the last two decades, whereas 50% for foreign assets. Source: IMF database)

²¹According to Du and Girma (2008), foreign firms were equally financed by local and national financial intermediation between 1999 and 2002; for technical reasons in this model, foreign firms are financed by the local credit market.

and hours worked.²²

The accumulation of capital has the following law of motion:

$$K_{d,t} = (1 - \delta_d) K_{d,t-1} + I_{d,t} \quad (12)$$

$$K_{d,t}^* = (1 - \delta_f) K_{d,t-1}^* + I_{d,t}^* \quad (13)$$

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 with a rate δ . Capital expropriation in China is modeled as a much higher and constant depreciation rate. This higher depreciation captures corruption in China (Angang (2001, 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 .

Firms can borrow additional capital; its domestic branch borrows in the country of origin, whereas its expatriated branch borrows abroad. The total amount of deposits available in domestic banks to lend to firms is the addition of household domestic savings and financial capital inflows (foreign bonds purchases from foreign households):

$$D_{d,T,t} = B_{d,t} + B_{f,t}^* \quad (14)$$

Then, the capital borrowed is proportionally distributed between domestic and expatriated foreign capital: $D_{d,t} = \left(\frac{K_{d,t}}{K_{d,t} + K_{f,t}^*} \right) D_{d,T,t}$ and $D_{d,t}^* = \left(\frac{K_{f,t}^*}{K_{d,t} + K_{f,t}^*} \right) D_{d,T,t}$. Frictions on the credit market are introduced so that firms face borrowing constraints ζ , that limit the amount of capital they can bring as collateral:²³

$$B_{d,t} = \zeta_d (K_{d,t} + K_{f,t}^*) \quad (15)$$

The tightness of borrowing constraints captures the financial development in each country, as in the standard literature (e.g., Mendoza, Quadrini, and Rios-Rull (2008), Song et al. (2011), and Coeurdacier et al. (2013), among others). A tighter (resp., looser) credit constraint is set in the country with a higher (resp., lower) moral hazard.²⁴

A very crucial assumption is that *domestic* firms do not reinvest their profits in production, but accumulate them and save them to buy foreign financial assets.¹⁵ This assumption is valid only for private firms, not for SOEs.²⁵

²²For example, $Y_{d,t}^*$ and the dynamic of expatriated capital become $y_{d,t}^* = \frac{Y_{d,t}^*}{A_{d,t}^*}$ and $k_{d,t}^* = (1 - \delta_f) \frac{K_{d,t-1}^*}{A_{d,t-1}^*} \cdot \frac{A_{d,t-1}^*}{A_{d,t}^*} + \frac{I_{d,t}^*}{A_{d,t}^*} = (1 - \delta_f) \frac{k_{d,t-1}^*}{1 + g_{A_f}} + i_{d,t}^*$, with $A_{d,t}^* = (1 + g_{A_f})^t A_{d,0}$ for expatriated firms. See the details in the appendix.

²³To bypass these credit constraints some private firms use FDI (see Hericourt and Poncet (2008)) or shadow banking (see Tsai (2002), Krugman (2011), and Funke, Mihaylovski, and Zhu (2015)). It is not modeled here to keep a simple framework.

²⁴One possible extension could be an endogenous credit constraint depending on moral hazard, or vice versa. Such an extension is, however, difficult to solve; technically the model would become too complex.

²⁵Indeed, the significant part of SOEs' profits disappears with corruption (Angang (2001, 2002), and Xiao and Kimball (2006)). Another part is invested abroad through FDI outflows, in fiscal paradises and countries with natural resources (Ramasamy, Yeung, and Laforet (2012)). The latter don't correspond to the U.S. economy, so these FDI outflows from SOEs are not considered here. Then, the minor part of their savings is invested in domestic production (Song et al. (2011)), but it is assumed as nil here.

Under this assumption, incomes on savings

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

are added to firms' profits. For instance total profits of domestic firms become:

$$\begin{aligned} \pi_{d,T,t} &= Y_{d,t} + Y_{d,t}^* + D_{d,t} - (1 + r_{d,t}) (1 - \gamma_d) D_{d,t-1} + D_{d,t}^* - (1 + r_{f,t}) (1 - \gamma_f) D_{d,t-1}^* \\ &\quad - (W_{d,t} N_{d,t} + I_{d,t}) - (W_{d,t}^* N_{d,t}^* + I_{d,t}^*) + IC_{d,t} \end{aligned}$$

with IC_d incomes on savings ($IC_d = r_{f,t-1} \cdot (1 - \gamma_f) \pi_{d,t-1} - \frac{\chi_d}{1 + \mu_d} (\pi_{d,t} - \pi_{d,t-1})^{1+\mu_d}$) and $\pi_{d,t-1}$ profits of non-expatriated domestic capital at the previous period ($\pi_{d,t} = [Y_{d,t} + D_{d,t} - (1 + r_{d,t}) (1 - \gamma_d) D_{d,t-1} - (W_{d,t} N_{d,t} + I_{d,t})]$). The share of Chinese firms expatriated abroad (d^*) does not have incomes on savings because the assumption is valid only in China. The incomes of U.S. expatriated firms in China are included in $\pi_{f,T,t}$ (total profits of U.S. firms). Foreign firms' profits (U.S. domestic firms and U.S. firms expatriated in China) become:

$$\begin{aligned} \pi_{f,T,t} &= \pi_{f,t} + \pi_{f,t}^* = Y_{f,t} + Y_{f,t}^* + D_{f,t} - (1 + r_{f,t}) (1 - \gamma_f) D_{f,t-1} + D_{f,t}^* - (1 + r_{d,t}) (1 - \gamma_d) D_{f,t-1}^* \\ &\quad - (W_{f,t} N_{f,t} + I_{f,t}) - (W_{f,t}^* N_{f,t}^* + I_{f,t}^*) + IC_{f,t}^* \end{aligned}$$

with $IC_{f,t}^* = r_{f,t-1} \cdot (1 - \gamma_f) \cdot \pi_{f,t-1}^* - \frac{\chi_d}{1 + \mu_d} (\pi_{f,t}^* - \pi_{f,t-1}^*)^{1+\mu_d}$. Note that firms located in the U.S. accumulate savings but do not buy foreign assets, contrary to private firms located in China (which invest their savings abroad under the assumption). Indeed, U.S. firms experienced a large cash-to-assets ratio from 1980 to 2006 (see Bates, Kahle, and Stulz (2009)). Furthermore, it might be specified that firms' program is not solve against the $\pi_{d,t}$ that considers financial returns on savings. The assumption about profits not reinvested in the real economy implies that firms make their investment choice in function of the expect value of profits at time t only after production. Incomes from past profits are necessarily added to accumulated savings and are not put in the optimization.

First order conditions imply:

$$(1 - \alpha_d) \frac{Y_{d,t}}{N_{d,t}} = W_{d,t} \quad (16)$$

$$(1 - \alpha_f) \frac{Y_{d,t}^*}{N_{d,t}^*} = W_{d,t}^* \quad (17)$$

$$E_t \left[\frac{\lambda_{d,t+1}}{\lambda_{d,t}} \left(1 - \delta_d + \alpha_d \frac{Y_{d,t+1}}{K_{d,t}} - \zeta_d (1 + r_{d,t}) (1 - \gamma_d) \right) - \left(\frac{1 - \zeta_d}{\beta} \right) \right] = 0 \quad (18)$$

$$E_t \left[\frac{\lambda_{d,t+1}}{\lambda_{d,t}} \left(1 - \delta_f + \alpha_d \frac{Y_{d,t+1}^*}{K_{d,t}^*} - \zeta_f (1 + r_{f,t}) (1 - \gamma_f) \right) - \left(\frac{1 - \zeta_f}{\beta} \right) \right] = 0 \quad (19)$$

Equations (16)-(17) are standard labor demands and Equations (18)-(19) capture the trade-offs between physical and financial capital. As firms have the choice to invest either in the domestic country or in the foreign country, the share of capital invested abroad depends on the marginal return on investment

compared to credit costs. The former depends on labor costs and supply, initial technology, TFP growth, the share of capital in production, and capital expropriation, whereas the latter rises with interest rate, the tightness of credit constraints, and moral hazard. A firm makes the choice to invest abroad when $1 - \delta_f + \alpha_d \frac{Y_{d,t+1}^*}{K_{d,t}^*} - \zeta_d (1 + r_{f,t}) (1 - \gamma_f)$ is larger than $1 - \delta_d + \alpha_d \frac{Y_{d,t+1}}{K_{d,t}} - \zeta_f (1 + r_{d,t}) (1 - \gamma_d)$.

Foreign firms solve the same problem with similar equations. Even under the assumption that $B_{f,t}^* = 0$, firms in the foreign country are indebted to domestic country (financial capital inflows in Equation (26)).

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): labor supply in the domestic country is $(N_{d,t} + N_{f,t}^*)$, and $(N_{f,t} + N_{d,t}^*)$ in the foreign country.

National GDP in each country is defined as:

$$\begin{aligned} GDP_{d,t} &= Y_{d,t} + Y_{f,t}^* & (20) \\ &= C_{d,t} + I_{d,t} + I_{f,t}^* + \frac{\chi_d}{1 + \mu_d} \left[(B_{d,t}^* - B_{d,t-1}^*)^{1+\mu_d} + (\pi_{d,t} - \pi_{d,t-1})^{1+\mu_d} + (\pi_{f,t}^* - \pi_{f,t-1}^*)^{1+\mu_d} \right] \end{aligned}$$

$$\begin{aligned} GDP_{f,t} &= Y_{f,t} + Y_{d,t}^* & (21) \\ &= C_{f,t} + I_{f,t} + I_{d,t}^* + \frac{\chi_f}{1 + \mu_f} (B_{f,t}^* - B_{f,t-1}^*)^{1+\mu_f} \end{aligned}$$

The clearing conditions on goods markets is the aggregation of domestic and foreign GDP:

$$\begin{aligned} GDP_{d,t} + GDP_{f,t} &= C_{d,t} + C_{f,t} + I_{d,t} + I_{f,t}^* + I_{f,t} + I_{d,t}^* + \frac{\chi_f}{1 + \mu_f} (B_{f,t}^* - B_{f,t-1}^*)^{1+\mu_f} \\ &+ \frac{\chi_d}{1 + \mu_d} \left[(B_{d,t}^* - B_{d,t-1}^*)^{1+\mu_d} + (\pi_{d,t} - \pi_{d,t-1})^{1+\mu_d} + (\pi_{f,t}^* - \pi_{f,t-1}^*)^{1+\mu_d} \right] \end{aligned} \quad (22)$$

Bonds market clearing conditions are the total deposits available in each country. In the domestic country, the total amount of deposits available in domestic banks to lend to firms is the addition of household domestic savings and financial capital inflows (foreign bonds purchases from U.S. households, which are nil with the assumption of negligible portfolio investments from U.S. to China). In the foreign country, financial capital from private Chinese firms and households is financing firms located in the U.S. (in addition to U.S. households). Aggregate deposits in the foreign country are:

$$D_{d,T,t} = B_{d,t} + B_{f,t}^* \quad (23)$$

$$= \zeta_d (K_{d,t} + K_{f,t}^*) \quad (24)$$

$$D_{f,T,t} = \text{domestic bonds} + \text{financial capital inflows} \quad (25)$$

$$= \zeta_f (K_{f,t} + K_{d,t}^*) + B_{d,t}^* + \pi_{d,t-1} + \pi_{f,t-1}^*$$

Similar to households, there is one firm of each type by country. It is the aggregation of n firms of type d , f^* , and S in the domestic country, and m firms of type f and d^* in the foreign country.²⁶ 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 (see the next subsection) and FDI-in/out (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 ($\forall k \in \{d, f^*, S\}$) :

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

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

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

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

$$\left\{ \begin{array}{l} C_{d,t}, C_{f,t}, B_{d,t}, B_{d,t}^*, B_{f,t}, B_{f,t}^*, r_{d,t}, r_{f,t}, W_{d,t}, W_{d,t}^*, W_{f,t}, W_{f,t}^*, W_{S,t}, N_{d,t}, N_{d,t}^*, N_{f,t}, N_{f,t}^*, N_{S,t}, \\ Y_{d,t}, Y_{d,t}^*, Y_{S,t}, Y_{f,t}, Y_{f,t}^*, K_{d,t}, K_{d,t}^*, K_{S,t}, K_{f,t}, K_{f,t}^*, I_{d,t}, I_{d,t}^*, I_{S,t}, I_{f,t}, I_{f,t}^* \end{array} \right\}_{t=0}^{\infty}$$

Net Foreign Assets are obtained consolidating the budget constraint of households with the expressions of firms' profits:

$$\begin{aligned} NFA_{d,t} &= (B_{d,t}^* - \pi_{d,t} - \pi_{f,t}^*) - B_{f,t}^* + I_{d,t}^* - I_{f,t}^* \\ &= \alpha_d Y_{d,t}^* - \alpha_f Y_{f,t}^* + (1 + r_{f,t})(1 - \gamma_f)(B_{d,t-1}^* + \pi_{d,t-1} + \pi_{f,t-1}^*) - (1 + r_{d,t})(1 - \gamma_d)B_{f,t-1}^* \\ &- \frac{\chi_d}{1 + \mu_d} \left[(B_{d,t}^* - B_{d,t-1}^*)^{1+\mu_d} + (\pi_{d,t} - \pi_{d,t-1})^{1+\mu_d} + (\pi_{f,t}^* - \pi_{f,t-1}^*)^{1+\mu_d} \right] + \left[\frac{\chi_f}{1 + \mu_f} (B_{f,t}^* - B_{f,t-1}^*)^{1+\mu_f} \right] \end{aligned} \quad (26)$$

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 incomes from abroad:

$$\begin{aligned} CA_{d,t} &= TB_{d,t} + NIC_{d,t} = Y_{d,t} + Y_{f,t}^* - C_{d,t} - I_{d,t} - I_{f,t}^* \\ &+ r_{f,t}(1 - \gamma_f)(B_{d,t-1}^* + \pi_{d,t} + \pi_{f,t}^*) - r_{d,t}(1 - \gamma_d)B_{f,t-1}^* \\ &+ \frac{\chi_f}{1 + \mu_f} (B_{f,t}^* - B_{f,t-1}^*)^{1+\mu_f} - \frac{\chi_d}{1 + \mu_d} \left[(B_{d,t}^* - B_{d,t-1}^*)^{1+\mu_d} + (\pi_{d,t} - \pi_{d,t-1})^{1+\mu_d} + (\pi_{f,t}^* - \pi_{f,t-1}^*)^{1+\mu_d} \right] \end{aligned} \quad (27)$$

²⁶ S is for SOEs, see the next subsection.

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

3.4 State-Owned Enterprises

SOEs are also introduced in the model. Those firms represented 85% of the employment share in China in the late 1980s, and then, 45% in 2008 (see Figure 4). SOEs are intensive in capital and have high investment rates due to better access to credit than private firms. However, SOEs have a lower productivity, which primarily explains why profits are low (see Figure 17 in Appendix). Corruption and excessive dividends distribution further low productivity and returns on capital.

An exogenous and decreasing share of employment in SOEs (η_{Soe}) is assumed in the economy to model the privatization process. The rest goes to private firms. SOEs do not expatriate capital abroad and maximize their profit in the same way as private firms:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \lambda_{d,t} \pi_{S,t} \quad (28)$$

where

$$\pi_{S,t} = D_{S,t} + Y_{S,t} - (1 + r_{d,t})(1 - \gamma_S) D_{S,t-1} - (W_{S,t} \cdot N_{S,t} + I_{S,t}) \quad (29)$$

with $D_{S,t} = B_{S,t} = \zeta_{Soe}(K_{d,t} + K_{d,t}^* + K_{S,t})$. Similar to private firms in China, SOEs are not financed by the foreign country ($B_{f,t}^* = 0$). The Cobb-Douglas production function and the law of motion of capital are identical to the private sector, only the calibration will change: the credit constraint is looser (higher ζ), the share of capital in production is higher (higher capital intensiveness), and the depreciation rate of capital is also higher (high capital expropriation); whereas TFP growth is lower. Even if a non-negligible share of SOE investments are made by internal savings (Song et al. (2011), and *China Fixed Asset Investment Statistical Yearbook*), it is supposed that SOEs do not grow their profits through foreign assets as domestic banks provide them with all of the required liquidity. Currently, the domestic labor force works either in SOEs or private firms (domestic or expatriate). Moreover, households have the choice to invest their savings in domestic private bonds, bonds issued by SOEs, or foreign bonds. Thus the welfare index becomes:

$$\text{Max} E_0 \sum_{t=0}^{\infty} \beta_d^t \left(\frac{C_{d,t}^{1-\sigma}}{1-\sigma} - \Phi \frac{N_{S,t}^{1+\psi} + N_{d,t}^{1+\psi} + N_{f,t}^{*1+\psi}}{1+\psi} \right), \quad (30)$$

subject to

$$\begin{aligned} C_{d,t} + B_{d,t} + B_{S,t} + \left[B_{d,t}^* + \frac{\chi_d}{1+\mu_d} (B_{d,t}^* - B_{d,t-1}^*)^{1+\mu_d} \right] &= (1 + r_{f,t})(1 - \gamma_f) B_{d,t-1}^* \\ &+ (1 + r_{d,t}) [(1 - \gamma_S) B_{S,t-1} + (1 - \gamma_d) B_{d,t-1}] + W_{d,t} N_{d,t} + W_{S,t} N_{S,t} + W_{f,t}^* N_{f,t}^* \end{aligned} \quad (31)$$

and labor supply and demand functions in the domestic country are:²⁷

$$\Phi\left(\frac{N_{d,t}}{1-\eta_{Soe}}\right)^\psi C_{d,t}^\sigma = W_{d,t} \quad (32) \quad \Phi\left(\frac{N_{f,t}^*}{1-\eta_{Soe}}\right)^\psi C_{d,t}^\sigma = W_{f,t}^* \quad (33) \quad \Phi\left(\frac{N_{S,t}}{\eta_{Soe}}\right)^\psi C_{d,t}^\sigma = W_{S,t} \quad (34)$$

$$(1-\alpha_d)\frac{Y_{d,t}}{N_{d,t}} = W_{d,t} \quad (1-\alpha_f)\frac{Y_{d,t}^*}{N_{d,t}^*} = W_{d,t}^* \quad (1-\alpha_S)\frac{Y_{S,t}}{N_{S,t}} = W_{S,t} \quad (35)$$

The current account becomes:

$$\begin{aligned} CA_{d,t} = TB_{d,t} + NIC_{d,t} = Y_{d,t} + Y_{f,t}^* + Y_{S,t} - C_{d,t} - I_{d,t} - I_{S,t} - I_{f,t}^* \\ + r_{f,t}(1-\gamma_f)(B_{d,t-1}^* + \pi_{d,t} + \pi_{f,t}^*) - r_{d,t}(1-\gamma_d)B_{f,t-1} + \frac{\chi_f}{1+\mu_f}(B_{f,t}^* - B_{f,t-1}^*)^{1+\mu_f} \\ - \frac{\chi_d}{1+\mu_d}\left[(B_{d,t}^* - B_{d,t-1}^*)^{1+\mu_d} + (\pi_{d,t} - \pi_{d,t-1})^{1+\mu_d} + (\pi_{f,t}^* - \pi_{f,t-1}^*)^{1+\mu_d}\right] \end{aligned} \quad (36)$$

Table 1: Variables

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 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 SOEs		
$B_{d,t}$	bonds financing domestic private firms	$B_{f,t}$	bonds financing domestic foreign firms
$B_{S,t}$	bonds financing SOEs		
$B_{f,t}^*$	bonds from U.S. households financing Chinese private firms	$B_{d,t}^*$	bonds from Chinese households financing U.S. private firms
$D_{d,T,t}$	total deposit	$D_{f,T,t}$	total deposit
$r_{d,t}$	interest rate	$r_{f,t}$	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 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 SOEs		
$K_{d,t}$	capital of domestic private firms	$K_{f,t}$	capital of foreign private firms
$K_{f,t}^*$	capital of expatriated U.S. private firms	$K_{d,t}^*$	capital of expatriated Chinese private firms
$K_{S,t}$	capital of SOEs		
$I_{d,t}$	investment of domestic private firms	$I_{f,t}$	investment of foreign private firms
$I_{f,t}^*$	investment of expatriated U.S. private firms	$I_{d,t}^*$	investment of expatriated Chinese private firms
$NFA_{d,t}$	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.

²⁷Note that labor supplies are modified at $t = 0$ to also calibrate the initial share of FDI, see subsection 4.4.

4 Calibration and data

The model is annual. The main objective of this calibration exercise is to reproduce the dynamics of capital flows (FDI and NFA) but also investments/savings and consumption over the last thirty years in China. It will result from a transition of the Chinese economy from a high to low share of SOEs (economic liberalization) and from high to low capital controls (financial liberalization). These economic and financial liberalizations are conducted under high TFP growth. Some parameters will remain fixed over time while other parameters will adjust along the way. All is summarized in Table 1.

4.1 Households

The calibration is classic for the discount rate β (0.97).²⁸ A higher ψ in China is utilized to have a fraction of time spent working close to 0.6 (0.4 for the U.S.). The risk aversion parameter σ is set to 1. With $\sigma > 1$, it is impossible to compute the model along the balanced growth. The parameters of households' 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.

4.2 Firms

Parameters α and δ are fixed to match the data for the marginal return on capital (at the steady state) in the 1980s. A higher δ in China captures capital expropriation (corruption, but 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 0.08.²⁹ The capital share in production is higher in the United States' firms (capital intensive). Regarding China, the initial calibration of the capital share is not equal to that of Song et al. (2011), primarily because they start their simulations in a second step of the transition in 1990s while here it starts in 1980s. The beginning of the transition was mainly a reallocation of the labor force from the countryside, hence a low capital share. Moreover, the source of Song et al. is NBS (the China's National Bureau of Statistic), which, according to Bai, Hsieh and Qian (2006), cannot indicate accurately the capital share. Indeed, financing through shadow banking and investment vehicles (which are not in the model) make the estimation difficult. In addition, note that the level of capital share can vary widely across sectors (Valentinyi and Herrendorf (2008), and Bai and Qian (2010)). The fact that a large part of investments in China were construction investments, which have a low capital share, strengthens an initial low calibration for the capital share. Then, the initial low capital share of SOEs (which are initially labor-intensive firms) is quickly rising with the hugely relaxing credit constraints along the transition, which fits the recent overinvestment. To finish, the initial calibration of the capital share is set by the steady state of marginal return on capital to fix it according to realistic values of capital depreciation and interest rate. Considering all of these elements, the calibration of capital share is initially set at the low level of 0.17. Then, SOEs can easily accumulate

²⁸With an other utility function decreasing the wealth effect, different values of the discount rates for China and the U.S. would even more impact households' savings. However, the model remains more unstable with this kind of utility function, so the first one detailed in the model section is preferred.

²⁹The lack of property rights protection also produces high capital losses in private firms. Therefore, the depreciation rate of capital in Chinese private firms is lower than in U.S. firms.

capital and increase investment with credit constraints relaxed along the transition. As for TFP growth, it is calibrated to the 1980s in the first periods of the model and adjusts gradually over time to reach TFP growth observed in the late 2000s.³⁰ For SOEs (resp., U.S.), TFP growth is initially at 0.7% (resp., 0.3%) but it does not increase over time. The initial level of technology in China (TFP at the beginning of the transition) represents 70% of U.S. TFP.³¹ Therefore, $A_{d,0}$ is calibrated at 1.06 and $A_{f,0}$ at 1.5. The share of employment in SOEs, η_{Soe} , is initially set to 0.75; that is, at the beginning of the liberalization of the Chinese economy in the late 1980s. Then, it falls gradually to 0.4. It is close to the data from *National Bureau of Statistics of China* and *China Labor Statistical Yearbook* outlined in Song et al. (2011).³²

4.3 Credit market

Credit constraints have a calibration close to Coeurdacier et al. (2013). They are tight for private Chinese firms ($\zeta_d = 0.02$ initially) while looser for SOEs and U.S. private firms ($\zeta_{S/f} = 0.2$ 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, both for SOEs and private firms, but at different degrees. In the end of the liberalization, ζ is really (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), and Funke, Mihaylovski, and Zhu (2015)). For the U.S., ζ is not increasing across time, but firms get more indebted with financial capital flows coming from Chinese private firms and households; 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. According to the World Bank database on financial development (*Global Financial Development Database (GFDD)*), the ratio of defaulting loans is fixed at 12% in the model. 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 (Xiao and Kimball (2006)).¹⁷ In the model, the magnitude and curvature of trading costs on bonds are set to match the data. Quadratic costs are considered, so $\mu_d = \mu_d = 1$. Capital controls are assumed to be zero in the U.S. ($\chi = 0$) and fall from $\chi = 0.4$ to $\chi = 0.02$ over the transition in China.

4.4 Size of countries and firms

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 ($\varrho_Y = \frac{\text{output}_d}{\text{output}_d + \text{output}_f} = 0.05$). 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

³⁰TFP growth is initially at 1% in China and 0.3% in the U.S.. For the latter, it is the annual average for the last 20 years; the maximum was at 2%.

³¹Source: World Bank (World Development Indicators).

³²The data concerning the share of employment in SOEs is initially close to 85 % and not 75 % in these two sources. The choice of 75 % is first used to provide a better fit to the data for endogenous variables, but is also justified: (i) The data is slightly different from a source to an other (the share of employment in SOEs can decrease until 80 % in the literature). (ii) The data sources remain opaque regarding the presence of foreign expatriated firms in the share of private firms; if it is not included, the share of SOEs is consequently lower in an adjusted data. (iii) In this model, if η_{Soe} would be initially set at 85 % then decreasing until 45% and not 40%, there would be a downward shift of some variables path ($B_{d,t}^*$ or $CA_{d,t}$) at the beginning of the transition. Therefore, η_{Soe} is initially set to 0.75 and falls gradually to 0.4.

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 and under the previous calibrations. Then, it also evolves endogenously. However, for FDI-out, it is impossible to match data values under the previous calibration in this framework, even at the beginning of the transition. It is not a crucial issue as the main focus of the study is FDI-in, and qualitatively there is a decrease of FDI-out relative to GDP under a large part of the transition (corresponding to the data, and the values do not become too high). As for SOEs, it is already mentioned that it gradually shifts from $\eta_{Soe} = 75\%$ to 40% over the transition (so an exogenous evolution). Thus, labor supply, marginal consumption, trading costs, and market clearing conditions become:

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

4.5 Forces driving the transition

The model replicates the Chinese transition from low to high growth utilizing TFP growth. Therefore, in particular, a deterministic shock of the TFP growth rate is set during 35 years in Chinese private firms. It shifts from 1% to 4.5% (the TFP growth average during the last twenty years in China in non-crisis

time is 4%). In addition, the liberalization is characterized in the model by: (i) an economic liberalization that is captured by having gradually a lower share of SOEs (from 75% to 40% with a path of almost 1% per year) (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).

Table 2: Calibration of the benchmark model

Parameters		China	U.S.
Constant parameters			
β	discount rate	0.97	0.97
σ	intertemporal elasticity of substitution	1	1
ψ	inverse of Frisch elasticity	4	1
μ	curvature of bonds trading costs	1	1
A_0	initial technology	1.06	1.5
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	0.05	
ω_{in}	initial share of FDI-in	0.007	
ω_{out}	initial share of FDI-out	0.001	
Economic liberalization			
η_{Soe}	share of SOEs	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

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

4.6 Results

The results are summarized in Figure 5 and Table 3. They report the evolution during the transition of key variables (current account and trade balance, foreign assets, FDI-in/out, consumption, saving and investment). All of these variables are expressed in percentage of GDP. Note that for the data of trade balance and FDI-in/out, China and the U.S. are considered as the sole partners: it is not against the rest of the world.

Table 3: Results (% GDP) - China

Variables (% GDP)	Middle of 1980s		Middle of 1990s		2007	
	Model	Data	Model	Data	Model	Data
Current account	-3.3	$\simeq 0$	8.8	1.5	11.9	10.1
Trade balance	-2.5	-0,25	8.9	1.38	11	4.35
Foreign assets	-26.7	4.6	3.5	10.5	40.3	43.8
FDI-in	6.3	1.15	10.3	14.5	17.8	20.2
FDI-out	1.4	0.08	2	2.6	2	3.3
Consumption	61.9	76.2	50.1	50.2	45	36
Aggregate saving rate	-4.4	35.7	22.1	42.1	62.8	51.8
Aggregate investment rate	32	35	44	42	50	41

First, notice that the model starts with a negative value for foreign assets in China (Figure 5, 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. Indeed, the initial share of SOEs is very large, and they have a large access to credit, so the major part of household savings goes to SOE bonds. Moreover, as the foreign interest rate is lower, they borrow abroad to maintain their initial high level of consumption (its determinants are explained in next paragraphs). Then, foreign assets become positive as in the data. Before going into the details in the sensitivity section, the rise in foreign assets primarily results from the growing share of private firms that are not sufficiently financed (contrary to SOEs). More productive, they accumulate profits, which are saved abroad. The large part of household savings is driven to SOEs all along the transition, but in the end, decreasing capital controls allow them to buy foreign bonds. This enhances the rise in Chinese foreign assets. These elements explain the growing level of foreign assets only under a higher TFP growth over time.

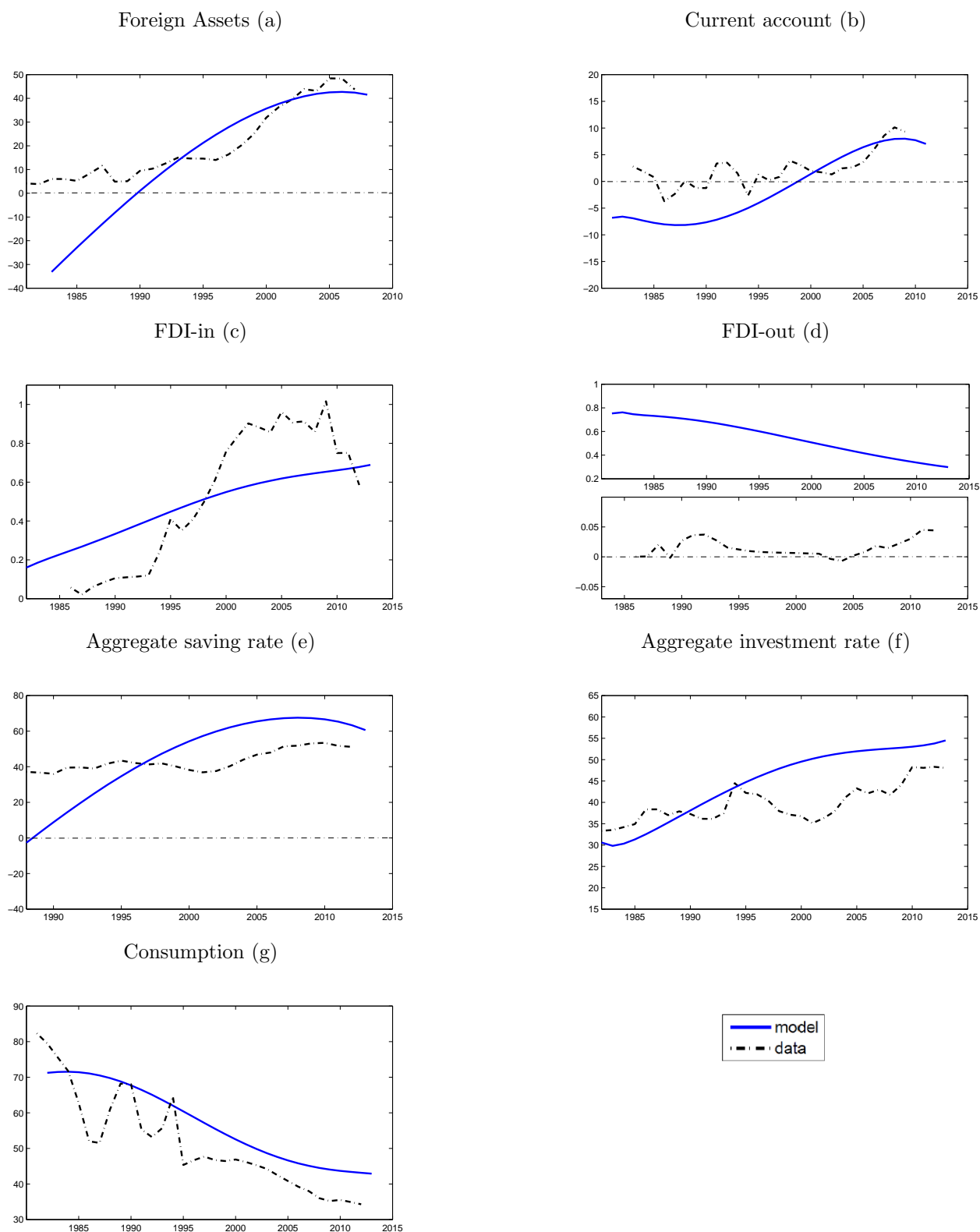


Figure 5: Results (% GDP) - China

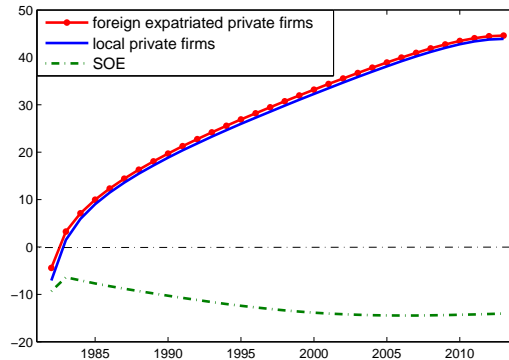


Figure 6: Firms' profits (% GDP of each firm) - China

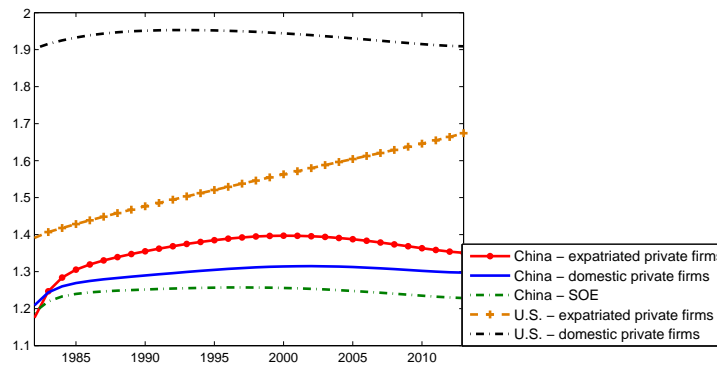


Figure 7: Wages

Regarding FDI, inflows (panel (c)) are growing contrary to outflows (panel (d)).³³ 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 outflows, the model does not fit well the data. However, qualitatively, the pattern observed in the data is reproduced, with a decreasing path to a low level. Concerning FDI inflows, note that starting in 2000, their increase has slowed (5.3% per year in 1995, 3.7% in 2012). It comes from higher wages in China due to growth catch-up and further amplified by progressively relaxing credit constraints. The model does not match the recent drop of inflows in the data: only the FDI growth rate decreases. It is all of the more surprising because wages of expatriate firms have a larger growth rate than domestic and U.S. wages (Figure 7). However, it can be explained by some elements attracting FDI-in: profits in private firms remain high (Figure 6), credit constraints are relaxed, and the path of TFP growth rate is constant at a high level even at the end of the transition. This decreasing growth rate of FDI with looser credit constraints is consistent with the work of Martin and Ventura (2012). Indeed, according to them, a rise in financial development would reduce FDI inflows. The determinants of FDI growth rate will also be developed in the next section, particularly the role of moral hazard. For the level

³³In absolute terms (not relative to GDP) the simulation predicts that FDI-in and -out are both growing: 182% against 15% over the last fifteen years. In terms of stocks over GDP, inflows are growing whereas outflows are decreasing; it is due to a higher growth path of GDP in China compared to its capital located in the U.S.

of FDI against GDP, it is important to remember that China and the U.S. are considered partners: it is not against the rest of the world (in this case, in China, FDI-in are close to 25% GDP in stock and 5% GDP for FDI-out).³⁴

The aggregate savings rate is nearly equally shared by households and firms at the end of the transition (Figure 9). It is consistent with the data of the last fifteen years and with some works such as Bayoumi, Tong, and Wei (2010) and Ma and Wang (2010), among others. Although the household savings rate has become closer to the data in the last years, it remains too high in the model in the middle of the transition. It is primarily due to inadequate capital controls on foreign bonds purchases but also because in this model, Chinese households finance a large part of the economy and finally 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 $SH_d = B_d^* + B_d + B_S$ and that of firms $SF_d = \pi_d + \pi_f^*$. When the assumption that firms save their profits abroad is relaxed, the amount of foreign assets is divided by two at the end of the transition (Figure 8). Only the amount of foreign bonds purchased by households remains.

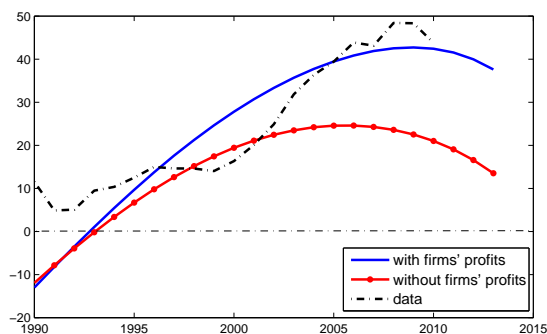


Figure 8: Foreign assets without firms profits (% GDP) - China

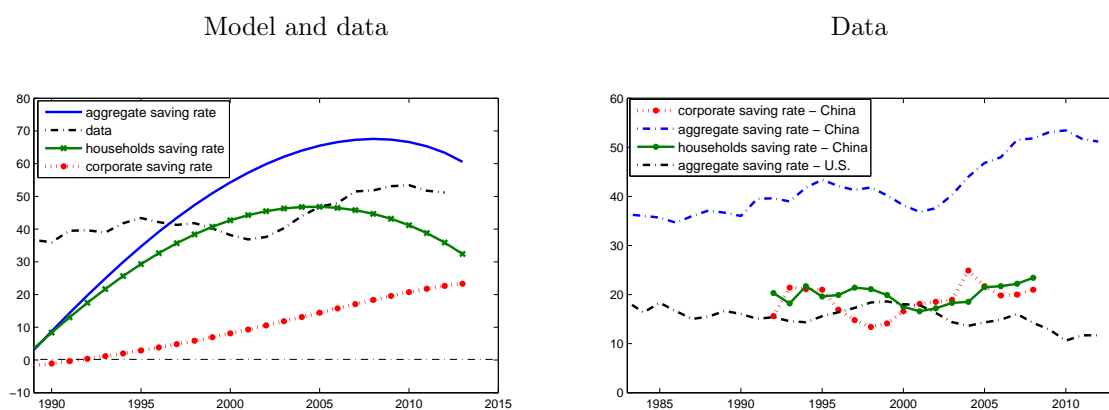


Figure 9: Saving rates (% GDP) - China

³⁴Source: OECD data

As for consumption in China, its decrease in the model is primarily due to financial intermediation: credit constraints for SOEs are highly relaxed along the transition. It modifies factor shares in the different types of firms: private firms (domestic and foreign expatriated) become labor intensive whereas SOEs capital intensive. With the increase in TFP growth in labor-intensive firms, labor demand with low wages increases, which raises households' time spent at work at low earnings. Combined with a higher Frisch elasticity in China, households consequently decrease leisure and consumption. Then, the other explanation in this model is that a large part of household savings has to be invested in SOE bonds with low returns, preventing any trade-off between all of the assets in the economy. The fact that public financial intermediation drives households savings to bonds with low returns reduces households' wealth and increases savings. Finally, once SOEs are sufficiently financed, households have the possibility to buy foreign bonds. This is the last element raising household savings: at the end of the transition, trading costs decrease widely and returns on U.S. bonds are higher, so households increase their foreign bonds purchases. As for U.S. consumption and savings, 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 make the U.S. indebted to China. This would raise the level of consumption and reduce savings in the U.S., moving closer to the data. However, relaxing this assumption would uselessly complicate the model.

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 becomes positive and large very quickly due to an output surge and to investment restrictions for private firms. In the late 1990s, the current account exceeded 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:

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

After 2007, financial development in China reached a level (credit constraints progressively relaxed) at which investment growth became higher than output growth, slowing the growth of $CA_{d,t}$ to GDP. It is amplified by the reduction of the stock of foreign assets at the end of the transition. Indeed, looser credit constraints direct household savings more significantly toward domestic bonds, reducing their purchases of foreign bonds.

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

$$rw_t = \frac{\omega_{in,t}.W_{f,t}^* + (1 - \omega_{in,t} - \eta_{Soe}).W_{d,t} + \eta_{Soe}.W_{S,t}}{\omega_{out,t}.W_{d,t}^* + (1 - \omega_{out,t}).W_{f,t}} \quad (37)$$

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

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 low calibration of the capital share). Then, the model approximation of the real exchange rate is following the slowly increasing trend of the data while remaining below (Figure 10). Even if these relative wages are just an approximation of the real exchange rate, it also means that the increasing share of labor-intensive firms (due to the misallocation of capital between private firms and SOEs) exerts downward pressure on the labor costs evolution compared to the U.S. one during the transition. Moreover, these relative labor costs are far from the relative TFP evolution; indeed, in the model, TFP has, on average, been growing 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 surplus but also the decrease in consumption (as explained in the previous results above and summarized in the next paragraph). This downward pressure on labor costs during all the transition in the model 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 relied on it.

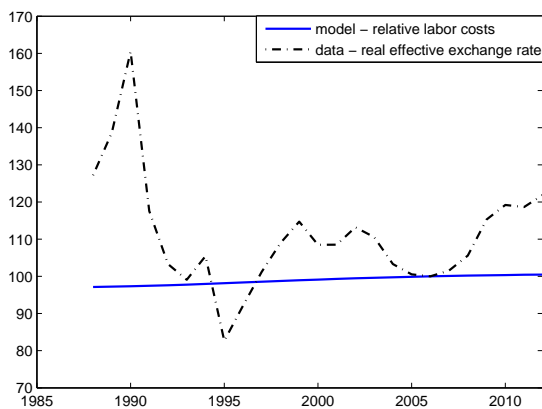


Figure 10: Relative labor costs and real effective exchange rate - China

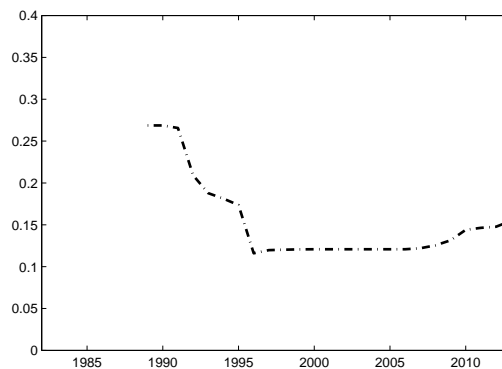


Figure 11: Official exchange rate

To summarize the dynamics of capital inflows and outflows, there are differences between the two countries in terms of aggregate savings and investments, and in terms of marginal product of capital (mpK) and returns on bonds. Savings are high in China and returns on bonds are lower than in the U.S.: financial capital flows out of the country. The investment rate is high (resp., low) in the U.S. (resp., in China) and mpK is higher in China: there are large FDI-inflows in China. Some elements create these distortions in savings/investments and mpK/returns on bonds. The crucial explanation is the financial intermediation in China: by driving households savings to SOEs and not to an increasing share of more productive private firms, the latter become labor intensive (unlike SOEs, which become capital intensive). The new private labor-intensive firms accumulate profits (with high TFP growth) and save it abroad (where financial markets are more developed) because there are credit frictions hindering private firms' investment in the domestic country. This raises China's accumulation of foreign assets. The other element increasing foreign assets is the household savings rate due to all of the elements explained above (mainly cheap labor demand in new private labor intensive and losses on SOE bonds' returns). With decreasing capital controls on foreign bonds purchases at the end of the transition, households significantly raise the level of foreign assets. Regarding FDI, as financial intermediation causes the emergence of new private labor-intensive firms by SOE overfinancing, it creates good opportunities for foreign firms to expatriate a share of their capital abroad. Indeed, in these new firms, wages remain low and TFP growth is high, hence, high mpK and profits. Therefore, the main element explaining this two-way pattern of FDI and financial capital is the way public financial intermediation drives households savings to SOEs. Capital controls have a role, but just at the end of the transition, by enhancing households' foreign bonds purchases. 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 rate, and moral hazard particularly decreases returns on bonds, FDI inflows, and the aggregate investments rate. For further details on the impact of each friction, see the sensitivity study. The good results regarding consumption highlight how crucial is the impact of the credit bias to SOEs: it explains the Chinese drop in consumption in this framework, in addition to create the two-way capital flows puzzle.

Qualitatively and quantitatively the model behaves well. It succeeds in solving the allocation puzzle and in matching the data for key stylized facts. To determine the contribution of each assumption and friction, we proceed to a systematic sensitivity analysis. Each friction and assumption are removed and the resulting dynamics are compared to the benchmark.

5 Sensitivity

5.1 SOEs and trading costs: the economic and financial liberalization

In the model, the economic liberalization means a decrease in the share of employment in SOEs (η_{SOE}) from 75 % to 40 % during the transition: the privatization of firms in China. 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 both assumptions are relaxed. Before going into more details, some key points about the impact of liberalization on the results (Figure 12) might be summarized. First, under heterogeneous credit constraints and TFP growth among firms, the transition from SOEs to private firms is the key element creating external surpluses. Indeed, as public banks finance more SOEs through household savings, the share of private labor-intensive firms is growing. Their low access to credit slows their investments, but with a high TFP growth and cheap labor demand they make profits and save them abroad. It creates large foreign assets and current account surpluses, in line with Song et al. (2011). Therefore, the privatization is at the origin of shifts in factor intensiveness and saving/investment behavior when combined with heterogeneous credit constraints. Second, the external surpluses are amplified by decreasing capital controls during the transition. Third, the lack of domestic investment (due to tight credit constraints and other elements described later) is offset by FDI-in, which has a high growth rate. In particular, TFP growth and low labor costs (Figure 7) attract it. It is the result of Ju and Wei (2010). Domestic capital does not go to the highest returns on investments and flows out of the country through savings on foreign bonds. These outflows are only partly offset by FDI inflows: the investment rate remains low, resulting in large external assets accumulation. Moreover, in the model, economic and financial liberalization have a significant impact on consumption; it is clear on panel (g): consumption remains constant or even increases without economic liberalization, whereas strongly decreases in the benchmark model. Indeed, during the transition lower trading costs make savings in foreign bonds more attractive, the loosening of credit constraints (particularly in SOEs) mechanically raises household savings with low returns, and households spend more time working to the detriment of leisure with the rising share of labor-intensive firms: these elements cause consumption to decrease. An other major result is the dynamics of the current account which is reversed without economic and financial liberalizations (Figure 12, panel (b)): a constant and high rate of well-financed SOEs promotes growth based on imports and indebtedness in this framework.

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 12 (panels (a) and (b)) where both assumptions are relaxed. Initially, under all scenarios, the Lucas Paradox does not appear at the beginning of the transition because the initial share of SOEs is very large. The assumption of a large share of SOEs is equivalent to low global credit constraints in China, as $\zeta_{SOE} > \zeta_{d/d^*}$. Households share their savings between domestic SOE bonds B_S and foreign bonds B_{d^*} . With low credit constraints the former meets the demand for savings from households; the latter is determined by Equation 7. Because the foreign interest rate is low and capital controls are high,

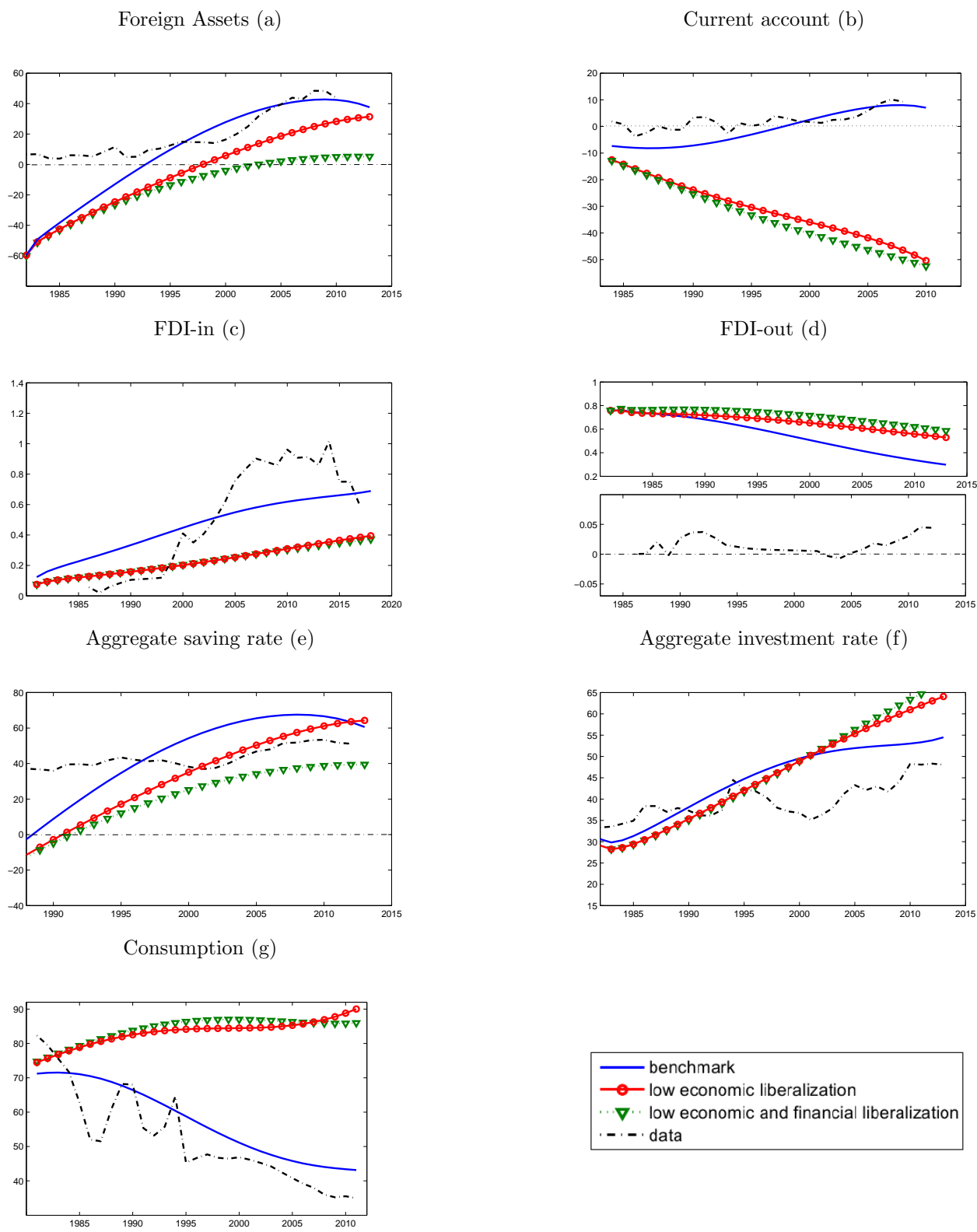


Figure 12: The impact of economic and financial liberalization (the share of employment in SOEs and capital controls), results in % GDP - China

they borrow abroad to maintain their high initial level of consumption. Then, in the benchmark, with the increasing share of private firms, the allocation of household savings to SOEs creates shifts in factor intensiveness by creating labor-intensive firms. This leads to rising corporate savings, but in particular, changes the consumption and savings behavior of households. The latter increase their time spent at work with low wages, and their savings rise (Figure 12, panel (g)). In addition to lower capital controls across time with financial integration, foreign assets reach a higher level (Figure 12, panel (a)). Note that if households could really trade-off between domestic and foreign bonds, it would change the dynamics of financial capital. As a matter of fact, the trade-off is distorted by the fixed amount firms can borrow, an amount globally attributed to SOEs. It is a distortion in the model but also in “reality” (Aglietta and Bai (2012)). If households could buy as many bonds of domestic private firms as they wanted (with high returns), the external surplus would be somehow smaller.

As for firms’ savings, SOEs are capital intensive with low productivity, compared with high productivity and labor intensiveness in private firms. In the benchmark, profits become higher in the latter (Figure 6 (17 for data)), and these new savings tend to be invested abroad.³⁵ This mechanism is amplified over time with the rising share of SOEs and financial liberalization. Relative to the size of domestic savings, the amount of foreign assets relative to GDP becomes huge. These effects are clearly reversed when both assumptions are relaxed. 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). Household savings are driven to SOEs, and financial integration overcomes the lack of capital in private firms with foreign financing through savings (as in Benhima (2013a)).

Regarding the current account, it is severely decreasing without economic liberalization because of a constant and high rate of capital-intensive SOEs (a growth based on imports and indebtedness in this framework). Thus, the aggregate investment rate rises faster at the end of the transition (Figure 12, 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 (Figure 12, panel (g)). Indeed, if the share of SOEs remains high during the entire transition, consumption rises. As a matter of fact, in this case (no privatization), there is not this rising share of credit constrained firms: households do not spend a lot of time working in new labor-intensive firms at low wages, so they consume more. This effect is strong in the model as it overturns the increase in household savings, which are driven to SOE bonds.³⁶ Like the other variables, the effect of economic liberalization on consumption is just amplified by the financial liberalization, but the latter is not crucial (it just increases household savings at the end of the transition because of the possibility to buy foreign bonds due to decreasing

³⁵Remember that financial intermediation does not pump firms’ savings as it does for households savings. Indeed, private firms have access to foreign financing and more developed financial products. That is why the assumption that firms accumulate profits and save them abroad is realistic, even if it is mostly done through sovereign wealth funds in reality.

³⁶Remember that SOEs have credit constraints, which are looser overtime than those of private firms. Thus, if the share of SOEs remains constants, it directly pushes further household savings to SOE bonds compared to the case under the privatization of firms. It is due to Equation (7), which is not a real trade-off. First, the amount of domestic bonds purchased by households is determined by the level of credit constraints and the capital accumulation of firms; then, households choose their amount of foreign bonds.

capital controls). As for the fall in consumption 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 (Figure 12, panels (c) and (d)).³⁷ The growth rate of FDI-in is slowed by growing wages, but they remain attractive with high TFP growth.³⁸ 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 financial capital inflows in the U.S. expands their local funding. It is to the detriment of opportunities in China through expatriate firms.

5.2 Credit market frictions

We now comment on the specific effects of credit market frictions. Figure 13 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 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 13, 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 (due to a better access to credit), and private firms labor intensive. The decreasing share of SOEs leads to a large proportion of labor-intensive firms. In the model, it maintains wages at a low level in private firms, attracting FDI-in (Figure 13, panel (c)). These 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 financial capital outflows. Thus, when credit constraints become looser, it is obvious that the aggregate savings rate, financial capital outflows, and the current account are reduced and that the domestic investment rate increases (Figure 13). These looser credit constraints also decrease slightly FDI inflows because they raise wages in foreign firms in China (Figure 18 in Appendix); thus, this increase in domestic wages due to looser credit constraints leads to a lower decrease in FDI outflows at the end of the transition (Figure 13, panel (d)). One issue with the 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 capital flight (when FDI and financial capital are aggregated, net capital flows are $B_{d^*} + \pi_d + \pi_{f^*} - B_{f^*} + I_{d^*} - I_{f^*}$).³⁹ Regarding consumption, it is negatively and mechanically (in this model) impacted by looser credit constraints (Figure 13, panel (g)). Indeed, firms

³⁷In terms of stock amount (not relative to GDP) FDI-in and -out are both growing: 182% against 15% during the last fifteen years. In terms of stocks over GDP, inflows are growing whereas outflows are decreasing; it is due to a higher growth path of GDP in China compared to its capital located in U.S.

³⁸Initially wages in China are of course lower than U.S. ones under this calibration. More precisely, those in foreign expatriated firms are higher than in domestic private ones and than in SOEs. Indeed, 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 Appendix.

³⁹That 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).

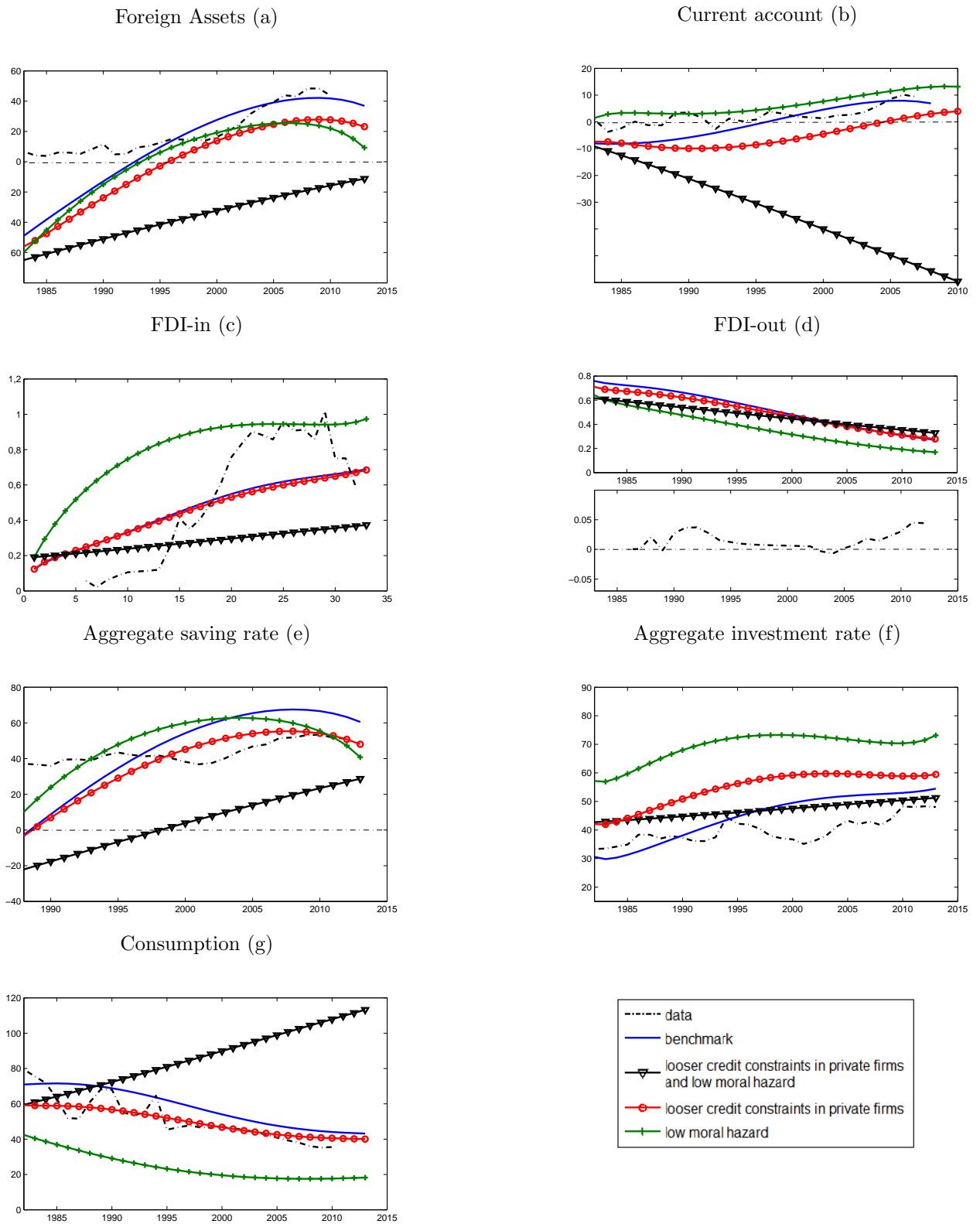


Figure 13: The impact of credit market frictions (credit constraints and moral hazard), results in % GDP - China

can borrow a larger amount of capital, which is directly taken from household savings.

Regarding moral hazard, this credit market friction is not well studied in the literature of global imbalances. In the benchmark model, its impact on financial capital outflows operates through two channels. First, lower moral hazard in the U.S. increases returns on foreign bonds and directly encourages Chinese households to buy them (Equation 7), once the major part of their savings was used to finance domestic firms (especially SOEs). Second, higher moral hazard in China raises financial capital outflows because it discourages investment in domestic private firms or through FDI (Figure 13, 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 return on domestic investments decreases and becomes lower than the borrowing interest rate; thus, corporate savings from labor-intensive firms increase, and so do financial capital outflows and the current account (Figure 13, panels (a) and (b)). When the assumption that moral hazard is high in China is relaxed, Figure 13 exhibits an increase in FDI-in, firms investments, and capital accumulation. The latter raises the amount firms can borrow; then, household savings increase mechanically in the model and consumption decreases. These combined effects result in reduced net foreign assets. However, lower moral hazard decreases firms' expatriation to U.S. (FDI-out). 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 FDI-out compared to FDI-in (in absolute terms) in China.

In the model, moral hazard amplifies the effect of credit constraints.⁴⁰ Foreign assets have a lower level when each credit market friction is separately looser. 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 13, panels (a)). It is the same for the savings rate. Regarding FDI-in, 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 13, panels (c)). The adjustment pattern of the current account is affected similarly. Indeed, low moral hazard increases the current account, and looser credit constraints produce deficits.⁴¹ 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 13, panels (b)). As an explanation, the high credit constraints to private firms (compared to SOE) by public banks are, as explained in the previous sections, the key element creating a pattern of increasing surpluses under high growth (from an initial pattern of increasing deficits under high growth when no credit bias, see Figure 12, panel (b)). However, moral hazard is just amplifying the external surpluses but not at the origin. Therefore, in this framework, the loosening of both credit frictions is amplifying the effect of looser credit constraints, as the latter are driving the transition to external surpluses, and

⁴⁰It 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.

⁴¹For 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.

moral hazard just amplifying it.

5.3 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.⁴² When the calibration of these parameters is adapted to the Chinese case, both assumptions amplify financial capital outflows and global imbalances (Figure 14, panel (a)). Indeed, a lower capital share and a higher depreciation rate of capital decrease returns on investments, so they raise the corporate savings rate and financial capital outflows. Moreover, the implied reduction in the marginal product of capital decreases (resp., increases) the growth rate of FDI-in (resp., out). A low share of capital in production raises the share of labor-intensive firms even under decreasing credit constraints. These firms are the main actor of the high corporate savings rate invested abroad.

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 $\delta_S (0.15) > \delta_d (0.12) > \delta_f (0.08)$. 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 self-evident: low capital expropriation decreases corporate savings (Figure 15) and financial capital outflows (Figure 14, panel (a)) and increases the investment rate (Figure 14, panel (f)). Note that the aggregate savings rate (Figure 14, panel (e)) rises slightly when capital expropriation is low. The latter decreases the corporate savings rate (Figure 15) but increases household savings. Indeed, there is more capital accumulation under low capital expropriation, which increases the amount firms can borrow. It directly raises the purchasing of domestic bonds by households.

The impact on FDI is also obvious: FDI-in increase and FDI-out decrease when there is less capital expropriation (Figure 14, panels (c) and (d)). The marginal product of capital is higher for the same level of credit costs, so investments are more attractive in China. As for consumption (Figure 14, panel (g)) the mechanism is also simple. When capital expropriation is low and the capital-to-output ratio is high, capital accumulation by firms rises, which increases the amount they can borrow. Purchases of

⁴²See Jin (2012) and the literature section 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.

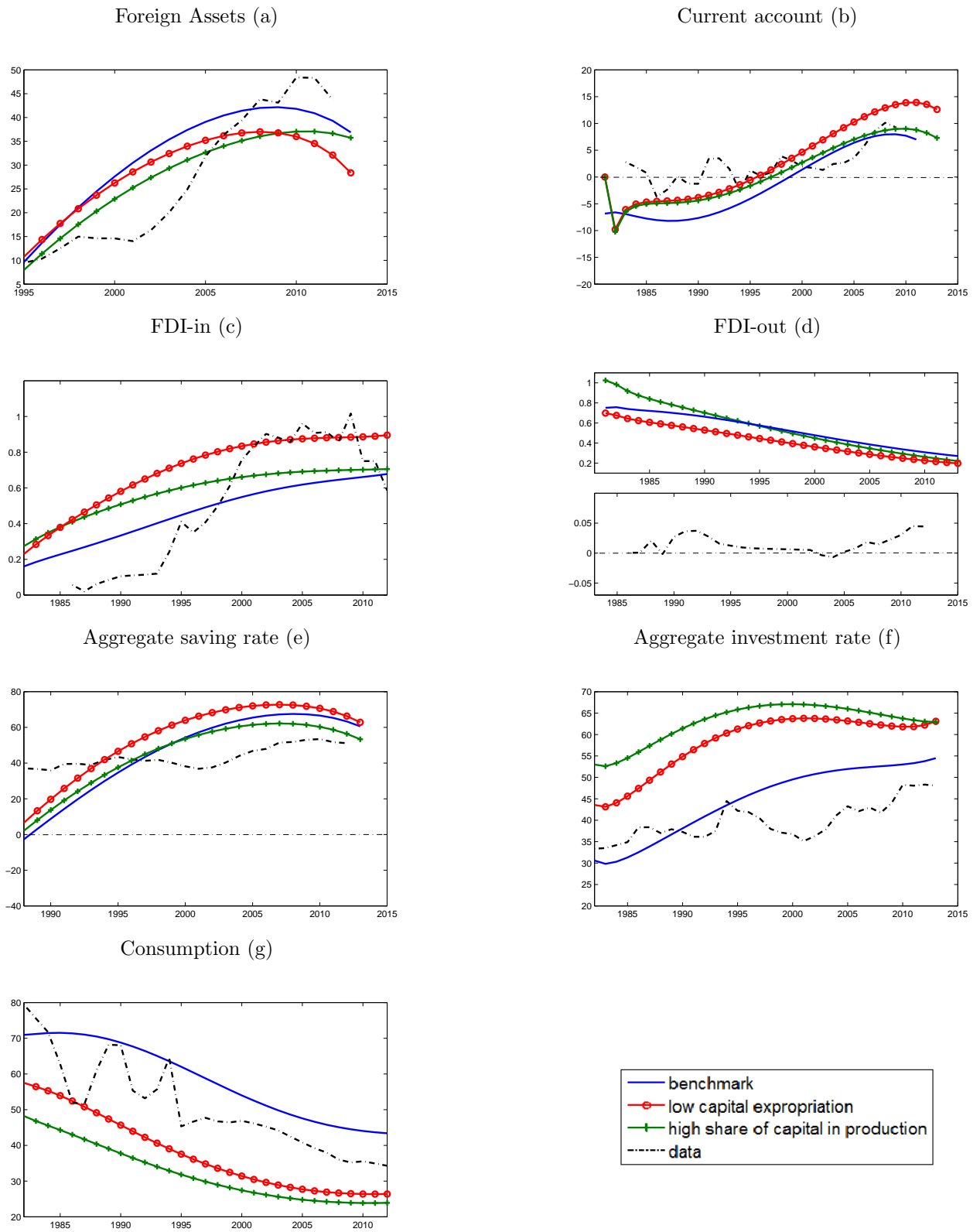


Figure 14: The impact of capital expropriation and the share of capital in production, results in % GDP - China

domestic bonds by households rise, and consumption falls.⁴³

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 FDI-in growth rate at the beginning of the transition with a similar final level, and the share of FDI-out becomes larger (Figure 14). Obviously the reaction of financial capital flows and FDI would be different if all types of firms had a large access to credit and were intensive in capital (a capital share in China close to the U.S. one).

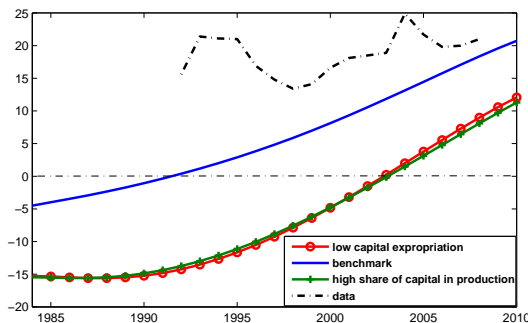


Figure 15: Firms' savings (% GDP) - China

5.4 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 credit and factor intensiveness distortions created by the misallocation of household savings to SOEs, matters the most to solve the two-way capital flows puzzle. 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 consumption which can also be explained by the distortions of credit and factor intensiveness during

⁴³However, this consumption behavior depending 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 impacts 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 do a real trade-off between foreign and domestic bonds, it would raise their purchases of domestic bonds (of private firms, with high returns) to the detriment of foreign ones. Moreover, the household savings rate should also be function of other structural elements, as the quality of pensions systems, social insurance, the demographic growth, ... These elements should drive household savings, and have a larger impact on consumption than the impact of domestic bonds due to lower capital expropriation.

privatization, due to the financial intermediation in favor of SOEs. Indeed, the sensitivity study show that without privatization or credit bias to SOEs, the consumption in China would be constant and high.

6 Conclusion

This study sheds light on the issues a privatizing emerging country could encounter. Indeed, when the public sector does not assist enough the growing private one, in addition to other credit and capital markets frictions, it can create external surpluses and lower domestic investment and consumption. All of the elements described above are structural elements and could be experienced by countries with an economic transition based on an “unbalanced” privatization.³

Under a progressive privatization of firms, the results demonstrate how important is the impact of credit market frictions, particularly that of heterogeneous credit constraints (low for SOEs, high for private firms). With high TFP growth, this financial intermediation (usually biased by public banks during a transition) could lead to an excessive aggregate savings rate hindering private firms’ investment and flowing abroad. It is exacerbated by financial liberalization. The increasing share of labor-intensive firms accumulating savings is not inevitable under privatization: if household savings were not driven to SOEs, the productive private firms would not become labor intensive and would not accumulate savings (then, not invested abroad). Moreover, households would not offer their cheap labor to the demand of these new firms, and they would have the choice between bonds of both private firms (with higher returns) and SOEs. Then, in this framework, their consumption would remain high. Regarding FDI, a large amount is attracted by the high TFP growth in China combined with low wages due to an increasing share of labor-intensive firms (due to the misallocation of capital). However, capital expropriation and moral hazard hinder it. The latter also interacts with credit constraints by magnifying their effect. One risk of keeping a large share of labor-intensive firms is a rise in wages due to looser credit constraints, which might decrease their returns and FDI inflows. The international risk is a reduction of FDI-in maintaining global imbalances as the foreign assets demand remains high in emerging countries. Capital controls would obviously reduce the risk, but its origin will be unchanged: the privatization under a biased financial intermediation misallocates capital, slows investment (in productive firms), and decreases consumption.⁴⁴

⁴⁴Regarding the decrease in consumption, as often mentioned in the paper, in the observed data there are also additional causes: low social protections and pensions, and also the housing bubble, largely increase household savings. As for the global imbalances phenomenon, the excessive indebtedness in developed countries also has an effect. There might be a two-way causality between the demand from developed countries for foreign loans (public and private) at low cost, which is met by the demand from emerging countries for high quality foreign assets.

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7 Appendix

7.1 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 national and g_A local, so U.S. firms expatriated in China have the following technology $A_{f,t}^* = (1 + g_{A_d})^t A_{f,0}$, and Chine 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:

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

$$y_{d,t} = \frac{Y_{d,t}}{A_{d,t}}$$

$$y_{d,t}^* = \frac{Y_{d,t}^*}{A_{d,t}^*}$$

$$y_{S,t} = \frac{Y_{S,t}}{A_{S,t}}$$

$$k_{d,t} = (1 - \delta_d) \frac{k_{d,t-1}}{1 + g_{A_d}} + i_{d,t}$$

$$k_{d,t}^* = (1 - \delta_f) \frac{k_{d,t-1}^*}{1 + g_{A_f}} + i_{d,t}^*$$

$$k_{S,t} = (1 - \delta_S) \frac{k_{S,t-1}}{1 + g_{A_S}} + i_{S,t}$$

$$b_{d,t} = \zeta_d (k_{d,t} + k_{d,t}^*)$$

$$b_{S,t} = \zeta_S (k_{S,t})$$

$$d_{d,T,t} = b_{d,t} + b_{S,t} + b_{f,t}^* = \zeta_d (k_{d,t} + k_{d,t}^*) + \zeta_S (k_{S,t}) + b_{f,t}^*$$

$$\begin{aligned}
d_{d,t} &= \left(\frac{k_{d,t}}{k_{d,t} + k_{d,t}^*} \right) \cdot d_{d,T,t} \\
d_{d,t}^* &= \left(\frac{k_{d,t}^*}{k_{d,t} + k_{d,t}^*} \right) \cdot d_{d,T,t} \\
IC_d &= r_{f,t-1} (1 - \gamma_f) \left[\frac{\pi_{d,t-1}}{1 + g_{A_f}} - \frac{\chi_d}{1 + \mu_d} \left[\left(\pi_{d,t} - \frac{\pi_{d,t-1}}{1 + g_{A_f}} \right)^{1 + \mu_d} \right] \right]
\end{aligned}$$

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

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

Foreign firms:

$$\begin{aligned}
\pi_{f,T,t} &= \pi_{f,t} + \pi_{f,t}^* = y_{f,t} + y_{f,t}^* + d_{f,t} + d_{f,t}^* + IC_f^* \\
-(1 + r_{f,t}) (1 - \gamma_f) \frac{d_{f,t-1}}{1 + g_{A_f}} &- (1 + r_{d,t}) (1 - \gamma_d) \frac{d_{f,t-1}^*}{1 + g_{A_d}} - (W_{f,t} N_{f,t} + i_{f,t}) - (W_{f,t}^* N_{f,t}^* + i_{f,t}^*)
\end{aligned}$$

$$\begin{aligned}
y_{f,t} &= \frac{Y_{f,t}}{A_{f,t}} \\
y_{f,t}^* &= \frac{Y_{f,t}^*}{A_{f,t}^*} \\
k_{f,t} &= (1 - \delta_f) \frac{k_{f,t-1}}{1 + g_{A_f}} + i_{f,t} \\
k_{f,t}^* &= (1 - \delta_d) \frac{k_{f,t-1}^*}{1 + g_{A_d}} + i_{f,t}^* \\
b_{f,t} &= \zeta_f (k_{f,t} + k_{f,t}^*) \\
d_{f,T,t} = b_{f,t} + b_{d,t}^* &= \zeta_f (k_{f,t} + k_{f,t}^*) + b_{d,t}^* \\
d_{f,t} &= \left(\frac{k_{f,t}}{k_{f,t} + k_{f,t}^*} \right) \cdot d_{f,T,t} \\
d_{f,t}^* &= \left(\frac{k_{f,t}^*}{k_{f,t} + k_{f,t}^*} \right) \cdot d_{f,T,t} \\
IC_f^* &= r_{f,t-1} (1 - \gamma_f) \left[\frac{\pi_{f^*,t-1}}{1 + g_{A_f}} - \frac{\chi_d}{1 + \mu_d} \left[\left(\pi_{f^*,t} - \frac{\pi_{f^*,t-1}}{1 + g_{A_f}} \right)^{1+\mu_d} \right] \right]
\end{aligned}$$

Again, using Bellman equation and the value function $V_{i,t} = u(c_{f,t}, N_{f,t}, N_{d,t}^*) + \beta_f E_t(V_{t+1}) - \lambda_{f,t}(\pi_{f,T,t})$, we get firms' FOCs:

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

Domestic households:

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

With $\sigma = 1$ (consistent with a deterministic shock) we get:

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

Foreign households:

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

With $\sigma = 1$ (consistent with a deterministic shock) we get:

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

7.2 Steady-state

-Real interest rates:

$$r_d = \frac{1}{\beta(1-\gamma_d)} - 1$$

$$r_f = \frac{1}{\beta(1-\gamma_f)} - 1$$

-Production:

$$y_d = \Upsilon_d^{\frac{\alpha_d}{\alpha_d-1}} N_d = \left[\frac{1}{\alpha_d} \cdot \left[\frac{\zeta_d(1+r_d)(1-\gamma_d)}{1+g_{Ad}} - \frac{1-\delta_d}{1+g_{Ad}} + \frac{1-\zeta_d}{\beta} \right] \right]^{\frac{\alpha_d}{\alpha_d-1}} N_d$$

$$y_{f^*} = \Upsilon_{f^*}^{\frac{\alpha_f}{\alpha_f-1}} N_{f^*} = \left[\frac{1}{\alpha_f} \cdot \left[\frac{\zeta_d(1+r_d)(1-\gamma_d)}{1+g_{Ad}} - \frac{1-\delta_d}{1+g_{Ad}} + \frac{1-\zeta_d}{\beta} \right] \right]^{\frac{\alpha_f}{\alpha_f-1}} N_{f^*}$$

$$y_S = \Upsilon_S^{\frac{\alpha_S}{\alpha_S-1}} N_S = \left[\frac{1}{\alpha_S} \cdot \left[\frac{\zeta_S(1+r_S)(1-\gamma_S)}{1+g_{AS}} - \frac{1-\delta_S}{1+g_{AS}} + \frac{1-\zeta_S}{\beta} \right] \right]^{\frac{\alpha_S}{\alpha_S-1}} N_S$$

$$y_f = \Upsilon_f^{\frac{\alpha_f}{\alpha_f-1}} N_f = \left[\frac{1}{\alpha_f} \cdot \left[\frac{\zeta_f(1+r_f)(1-\gamma_f)}{1+g_{Af}} - \frac{1-\delta_f}{1+g_{Af}} + \frac{1-\zeta_f}{\beta} \right] \right]^{\frac{\alpha_f}{\alpha_f-1}} N_f$$

$$y_{d^*} = \Upsilon_{d^*}^{\frac{\alpha_d}{\alpha_d-1}} N_{d^*} = \left[\frac{1}{\alpha_d} \cdot \left[\frac{\zeta_f(1+r_f)(1-\gamma_f)}{1+g_{Af}} - \frac{1-\delta_f}{1+g_{Af}} + \frac{1-\zeta_f}{\beta} \right] \right]^{\frac{\alpha_d}{\alpha_d-1}} N_{d^*}$$

-Capital:

$$k_d = \Upsilon_d^{\frac{1}{\alpha_d-1}} N_d$$

$$k_{f^*} = \Upsilon_{f^*}^{\frac{1}{\alpha_f-1}} N_{f^*}$$

$$k_S = \Upsilon_S^{\frac{1}{\alpha_S-1}} N_S$$

$$k_f = \Upsilon_f^{\frac{1}{\alpha_f-1}} N_f$$

$$k_{d^*} = \Upsilon_{d^*}^{\frac{1}{\alpha_d-1}} N_{d^*}$$

-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:

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

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:

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

7.3 Other figures

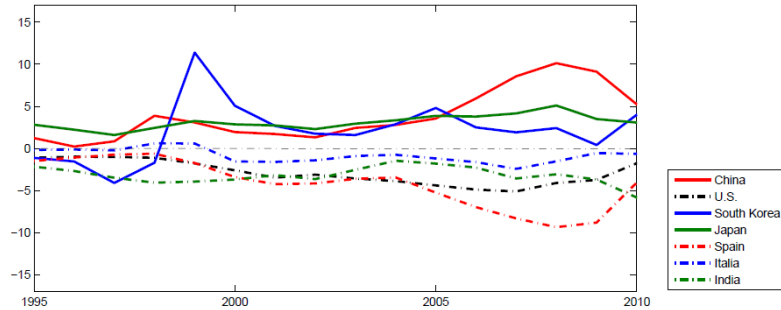


Figure 16: Current accounts (% GDP)
Source: IMF database

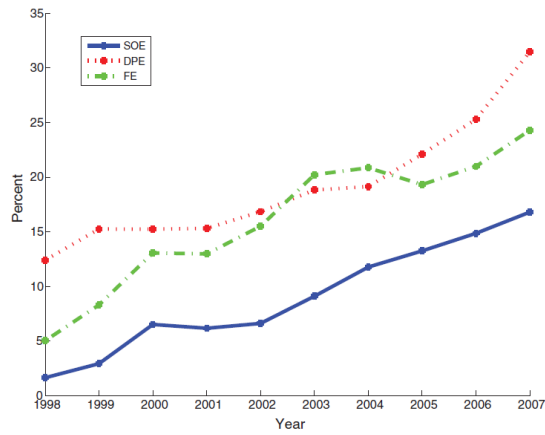


Figure 17: Total profits over net value of fixed assets - Source: Song and al. (2011) (CSY, various issues)
DPE: domestic private enterprises
FE: foreign enterprises

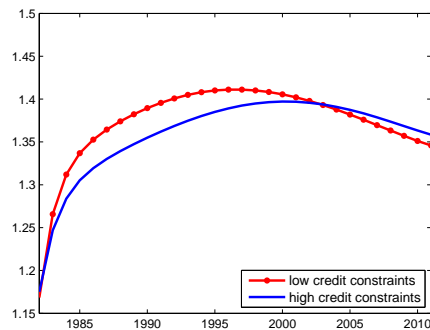


Figure 18: Wages in foreign expatriated firms under high and low credit constraints - China