Capital flows and economic liberalization: the Chinese case

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Abstract

Some emerging countries face an allocation puzzle of capital flows during their economic transition. This paper studies deeper this issue, highlighting the relation between private and public sector. It proposes a dynamic general equilibrium growth model differentiating FDI and financial capital, where public banks and State-Owned Enterprises (SOE) have a crucial role in the capital misallocation. It focuses on the Chinese case, but it can extend to other high growth emerging countries privatizing. While the saving rate is high in China, this country invests the vast majority of its assets abroad whereas FDI are attracted. The model solves the allocation puzzle of Chinese capital inflows and outflows, mainly with public banks creating credit distortions by driving a large share of households savings to SOE. In addition to the impact of the public sector, there are other interesting and sensible findings. One is the often underestimated impact of moral hazard and capital expropriation on external surpluses, which is shed light on here. Then in this model, under a framework of economic transition, the decrease in Chinese domestic consumption can not be overcome. The calibration to the Chinese case matches to a large extent the data for a variety of stylized facts over the last 30 years. The capital misallocation in China is a main element of international global imbalances, and this work is in line with the literature emphasizing the role of structural imperfections rather than an exchange rate manipulation.

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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 take into account the key role of public banks and State-Owned Enterprises (SOE), 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). The main contribution of this paper is to take into account these last elements. It also identifies the key assumptions driving external imbalances among a variety of potential explanations. Indeed, capital expropriation, moral hazard, capital controls, or the capital share, are also taken into account here, and have an impact on the capital misallocation and external surpluses. The key elements creating the latters, under a context of high TFP growth, are the privatization of firms and their labor/capital intensiveness, the misallocation of capital by public banks, and credit market frictions. Capital expropriation also has an influence, enhancing propensity to save of firms. Contrary to a part of the literature, the financial liberalization just amplifies the external imbalances but is not at the origin. An additional interesting result of the paper is to relate the assumptions and frictions creating external imbalances to the decrease in consumption in China. Here, the increase of the employment share in private labor intensive firms with low wages, and the way public banks allocate households deposits, increase households saving rate. All the elements described above are structural issues, and can be experienced by countries with an economic transition based on an “unbalanced” privatization.

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). Chinese saving rate was over 50 % in the late 2000s, resulting from an excessive saving rate both for households and firms, Figure 3. These savings were massively invested on foreign financial markets: foreign assets over GDP went up to 50 % whereas FDI entered massively in the country (but at a lower level related to GDP (see Figures 1 and 2)). Consumption was surprisingly decreasing all along the transition in China (Figure 3), and investments in the domestic real economy were hindered.

This paper is particularly close to Song, Storesletten, and Zilibotti (2011), especially for the role of SOE.

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1 Indeed, emerging (especially Asian) economies experience large FDI inflows while portfolio investments flowing out are usually large and exceed FDI inflows, generating large net foreign assets positions (see Figures 1 and 2). This misallocation of capital is mostly due to an excessive saving rate (corporate and households, see Figure 3).

2 Here capital expropriation includes corruption, the lack of property rights protection, and excessive dividends distribution. For corruption see Angang (2001, 2002), Lee and Xiao (2003) for excessive dividends distribution, and Ju and Wei (2010) for the lack of property rights protection.

3 The model is already heavy and enough difficult technically, that is why some determinants of households savings can not be taken into account (for example, the bad quality of social insurance, pension system, property rights protection (see Chamon and Prasad (2010), Horioka and Wan (2007), Wei and Zhang (2011), among others...)).

4 In 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, benefitting SOE to the detriment of an increasing share of private firms.
and credit constraints. However, this theoretical framework is different (Song and al. have an OLG structure), it distinguishes between FDI and other financial flows, and allows for additional assumptions (capital expropriation, moral hazard and capital controls). As 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 rises saving rates and financial capital outflows. However, if some assumptions of Ju and Wei are relevant and taken into account 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. Then, the role of the financial liberalization in the model is not as important as it is in Benhima (2013a). This study also completes the existing literature on Chinese decrease in consumption, giving new explanations in addition to the bad quality of social insurance, pension system, property rights protection (see Chamon and Prasad (2010), Horioka and Wan (2007), Wei and Zhang (2011), among others). Finally it sheds on light the risks of capital misallocation and external imbalances when banks privatization doesn’t completely assist firms privatization. Thus it completes the literature on the effects of privatization in developing countries (Meggison and Netter (2001), Boyreau-Debray (2003), Boyreau-Debray and Wei (2005), Estrin, Hanousek, and Svejnar (2009), among others).

What are the main elements of the model and basic mechanisms? The framework is a simple two-country dynamic general equilibrium growth model. There are different types of firms: State-Owned Enterprises (SOE), private domestic and expatriated firms (from the rest of the world, here the U.S.). An economic liberalization is considered (firms privatization with a decreasing share of SOE along the transition) and also a financial liberalization (less capital controls across time). There are two types of capital flows: FDI (firms can chose to invest abroad or not), and financial capital flows (bonds financing firms). In the domestic country (China), public banks drive households savings to SOE, to the detriment of private firms despite their high TFP growth: SOE become capital intensive and private firms labor intensive.

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5 Here, the lack of property rights protection is included with corruption and excessive dividends distribution in a global capital expropriation factor. See the model section for a detailed explanation of how expropriation is modeled.

6 In this figure current accounts are not presented relatively to GDP because of some countries as Singapour and Hong-Kong, having large amounts of financial transactions relatively to domestic production, so involving huge current accounts in % GDP (close to 100). For current accounts in GDP, see Figure 15 in appendix.
Combined with other frictions like moral hazard and capital expropriation, the 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 make FDI enter the country; but public financial intermediation and frictions on credit and capital market hinder investment and consumption. Thus firms profits and households savings are invested abroad through financial assets. As for consumption, in this framework, the privatization of firms (a lot of time spent at work with low wages), the low returns on deposits with public financial intermediation, and the financial liberalization, rise households savings which are invested either in SOE 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.

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 (economic and financial liberalization, credit market frictions, and capital losses).
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, as deficient institutions, governance, credit markets, social insurance, ... lead to high saving (respectively investment) rates in emerging (respectively developed) countries (Blanchard and Milesi-Ferretti (2009)). Given the low level of financial development and financial deepness in emerging countries, savings flow towards 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).\textsuperscript{7}

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 saving puzzle related to growth (see also Coeurdacier, Guibaud, and Jin (2012)), productivity, and the accumulation of international reserves. Emerging economies with high (resp. low) productivity growth tend to export (resp. import) capital.\textsuperscript{8}

The surge in financial capital flows from emerging to developed countries has many consequences, as the induced external surpluses and deficit. 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.\textsuperscript{9}

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

\textsuperscript{7}Caballero and al. (2008a) extend this "global saving glut" by giving a possible explanation of recent assets bubbles. The high assets demand mainly comes from emerging countries since two decades, first creating an asset bubble in East Asia in the 1990s. After its collapse, the high assets demand moved to United States through Nasdaq, then was extended to credit and housing market. The 2008 financial crises brought the bubble to commodities markets, then it came back to U.S markets when commodities demand dropped (with the world economy collapse).

\textsuperscript{8}This allocation puzzle is very close to the Lucas Paradox but remains different. The Lucas Paradox emphasizes that the volume of capital flows to the average developing country 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).

\textsuperscript{9}The surge in financial capital flows to the U.S. is one of the elements enhancing U.S. massive deficit and lowering world real interest rates. Thus there is a high share of U.S. assets in portfolios from reserves accumulation in emerging countries (particularly in China).
China), the latters 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 done in a dynamic general equilibrium growth model, especially allowing for the impact of TFP growth. Without FDI, Caballero and al. (2008b) is an excellent theoretical explanation of the phenomenon, but only at a macro and financial view. The second weak point in the related literature is the lack of specification of all structural imperfections hindering investment (creating excessive saving rates) 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). This more micro view of Chinese transition and its manufacturing sector emphasizes, among others, the role of heterogeneous credit constraints between SOE (a better access to finance) and private firms (with tightened credit constraints). The latters, more productive, become labor intensive and accumulate profits which are saved abroad. However, the work of Song and al. (2011) does not model FDI in/outflows paths, nor the impacts of other frictions as moral hazard, capital controls, and capital expropriation. The latters are included in Ju and Wei’s model and are the main drivers of financial capital and FDI paths. 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 Jin (2012) and Song and al. (2011)). The Chinese manufacturing sector having a decreasing (resp. increasing) share of more financed SOE (resp. credit constrained private firms), 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 receive 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 towards countries getting 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. 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 like 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 effect. 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

10 As in this work, SOE 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)).

11 For capital expropriation it is the introduction of property rights protection, dissociated from the financial sector (what is closed 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.
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.\textsuperscript{12}

Although goods are traded across countries in this paper, the interaction between trade theory and capital flows is not the main focus. Jin (2012) and Antras and Caballero (2009) go further in this approach.\textsuperscript{13} 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.\textsuperscript{14} Here, financial liberalization and capital controls have clearly a poorer effect. Factor intensities and structural imperfections on capital and credit markets are the foundations of Chinese foreign surpluses. That is why the paper sides with the literature minimizing an exchange rate manipulation by Chinese authorities (see Song and al. (2011)). Regarding credit market imperfections, one main reason is the way public banks operate in the financial intermediation: it directly pumps households savings through low deposit rates to finance SOE. 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 could be done.\textsuperscript{15}

This study gives new explanations regarding the Chinese decrease in consumption. The existing literature mainly highlights elements creating precautionary savings: rising 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), 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 rises the time households spend at work, with wages remaining low. Added to the low returns on deposits with public financial intermediation, and to the financial liberalization, households savings rise and are invested either in SOE or abroad.

Finally it sheds on light the risks of capital misallocation and external imbalances when banks privatization doesn’t completely assist firms 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 SOE 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 postcommunist (transition) economies and

\textsuperscript{12}This conclusion is more precise with a distinction between FDI and financial capital flows, see the sensitivity part in section 5.

\textsuperscript{13}The theoretical study of Antras and Caballero (2009) explains how net capital inflows are raised by a deeper trade integration, implying at a global level the set up of protectionism in order to rebalance capital flows. They demonstrate it first by isolating from trade the effects of heterogeneity in financial development on capital flows, then introducing Heckscher-Ohlin determinants of international trade.

\textsuperscript{14}According 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.

\textsuperscript{15}Indeed, 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 and at the same time increase consumption.
China. They find that although the effect of privatization is mostly positive in Central Europe, it remains ambiguous in many studies on China (here the results are in line with these studies). Megginson and Netter (2001) also make an interesting summary of research works on the effects of privatization in different countries.

3 A two-country model

A model of two large countries labeled \(d\) (domestic) and \(f\) (foreign) is built, with infinite horizon. To fit with 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. These investments are labeled financial capital flows. 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 using a standard Cobb Douglas technology. TFP growth is considered to model growth differentials between the U.S. and China. In China, State-Owned Enterprises (SOE) are added to private domestic and foreign firms. They are less productive but have a better access to credit (public banks relax credit constraints for SOE, 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 SOE. In addition, 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, lack of property rights protection, ...) modeled as a potentially higher depreciation rate of capital. A key assumption makes firms accumulate savings with profits and invest them abroad (also labeled financial capital flows). Finally, the model is focused on real factors and abstracts from nominal rigidities and exchange rate issues. Relative prices are assumed to be one. This set of frictions and assumptions under privatization affects savings and investments, so financial capital flows and FDI. The model shows that a realistic calibration exercise fully solves the allocation puzzle, and matches the data for the stylized facts described in the introduction.

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16 In reality these investments are made by banks and investment funds after sterilization of households’ savings. Including this would complicate and burden too much the model.

17 This assumption is realistic, see Bayoumi, Tong, and Wei (2010), Benhima (2013a), Caballero and al. (2008), Song and al. (2011), ... among others. Relying on data, Song and 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 less affect firms than households (indeed, the latters are almost constrained to invest their savings domestically in SOE (creating distortions in credit interest rate, see Aglietta and Bai (2012))). Like households’ savings, it might be highlighted that corporate savings are in reality invested on assets by banks and investment funds after sterilization, but it would make the model too complicated.

18 In this model the nominal exchange rate can not be considered without prices of goods, nominal rigidities, nor value function for bonds prices. As for the real exchange rate, including it would consequently raise the model technicality which is already quite large with several frictions and assumptions. Nevertheless, the relative marginal costs and wages give an idea of the real exchange rate evolution. It is important to note that the good results obtained with the absence of exchange rate highlight how crucial is the impact of structural imperfections on Chinese foreign surpluses. As outlined by Song and al. (2011), a manipulation of the exchange rate by the authorities has surely been overestimated.
3.1 Households

Domestic households maximize a welfare index:

\[
\max_{E_0} \sum_{t=0}^{\infty} \beta^t \left( \frac{C_{d,t}^{1-\sigma} - \Phi N_{d,t}^{1+\psi} + N_{f,t}^{1+\psi}}{1-\sigma} \right),
\]

subject to the budget constraint:

\[
C_{d,t} + B_{d,t} + \left[ B_{d,t}^* + \frac{X_d}{1+\mu_d} (B_{d,t}^* - B_{d,t-1}^*)^{1+\mu_d} \right] = (1 + r_{f,t}) (1 - \gamma_f) B_{d,t-1}^* + (1 + r_{d,t}) (1 - \gamma_d) B_{d,t-1} + W_{d,t} N_{d,t} + W_{f,t} N_{f,t}^*
\]

In Equation (2) \( \beta \) is the discount rate, \( \psi \) the inverse of the Frisch elasticity of labor supply, and \( \sigma \) 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 \((W_{d,t} N_{d,t} \text{ from domestic firm, } W_{f,t}^* N_{f,t}^* \text{ from foreign expatriated firms})\) are partly consumed in a single good and saved using 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 using households’ savings. In accordance with the main literature (particularly Song and al. (2011)), it is considered that financial markets are incomplete. In Equation (2) \( r_{d/f,t} \) are domestic and foreign real interest rates, and an exogenous ratio \( \gamma \) 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 \(\frac{X_d}{1+\mu_d} (B_{d,t}^* - B_{d,t-1}^*)^{1+\mu_d}\). These costs are a proxy for capital controls. Parameter \( \chi_d \) controls the magnitude of costs and \( \mu \) their curvature.\(^{19}\) Note that trading costs are based on new bond purchases at time \(t\) and not on the divergence from the steady-state.\(^{20}\)

\(^{19}\)Chinese financial integration is more complex. However, there are different limited amounts and taxes depending on the direction and type of financial flows. And it is varying during the transition. According to Xiao and Kimball (2006) and Annual Report of Exchange Arrangements and Exchange Restrictions (AREAER), a lot of 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, 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.

\(^{20}\)It 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: \(\frac{X_d}{1+\mu} (B_{d,t}^* - B_{d,t-1}^*)^{1+\mu}\)). However, deterministic simulations are conducted, so it is not a crucial issue.
First ordinary conditions are:

\[ N_{d,t} = \left[ \frac{W_{d,t} C_{d,t}^{-\sigma}}{\Phi} \right]^{1/\gamma} \]  \hspace{1cm} (3)

\[ N_{f,t}^* = \left[ \frac{W_{f,t}^* C_{d,t}^{-\sigma}}{\Phi} \right]^{1/\gamma} \]  \hspace{1cm} (4)

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

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

(3) and (4) are households labor supply to firms. For simplicity, 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 behaviour of the variables.\(^{21}\) 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 cleared in the next section).

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

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

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

As explained at the beginning of the model section, it is not impacted by nominal rigidities and exchange rate issues.\(^{18}\)

**Foreign households** solve the same problem with the additional constraint that their do not buy foreign bonds \((B_{f,t}^* = 0)\).\(^{22}\)

### 3.2 Firms

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

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\(^{21}\)In 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)).

\(^{22}\)Indeed, 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)
**Domestic firms** accumulate capital, produce, and maximize their stream of profits:

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

with

$$\pi_{d,T,t} = \pi_{d,t} + \pi_{d,t}^* = Y_{d,t} + Y_{d,t}^* + D_{d,t} - (1 + r_{d,t}) (1 + \gamma_{d}) D_{d,t-1} + D_{d,t}^*$$

$$- (1 + r_{f,t}) (1 - \gamma_{f}) D_{d,t-1}^* - (W_{d,t} N_{d,t} + I_{d,t}) - (W_{d,t}^* N_{d,t}^* + I_{d,t}^*)$$

Production combines labor and capital through Cobb-Douglas technology, with capital share $\alpha$ and labor share $1 - \alpha$. Firms operate in both countries. A share of its capital is expatriated, it is equivalent to invest in the foreign country through FDI.\(^{23}\) When expatriated, firms have their national production technology, TFP initial level, and capital share. However, they benefit from local TFP growth, labor force, and funding.\(^{24}\) Production functions are:

$$Y_{d,t} = A_{d,t} K_{d,t}^{\alpha_d} d_{d,t-1}^{1-\alpha_d}$$

$$Y_{d,t}^* = A_{f,t}^* K_{d,t}^{\alpha_d} d_{d,t-1}^{1-\alpha_d}$$

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 $g_A$: $A_t = (1 + g_A) A_{t-1} = (1 + g_A)^t A_0$.\(^{25}\) Of course it is assumed that $g_A > g_A^f$, so that TFP growth in China is larger 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 and hours worked.\(^{26}\)

The accumulation of capital has the following low of motion:

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

$$K_{d,t}^* = (1 - \delta_{f}) K_{d,t-1}^* + I_{d,t}^*$$

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 $\delta$. Capital expropriation in China is modeled as a much higher and constant depreciation rate.\(^{27}\)

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

\(^{23}\)So for domestic firms $\pi_{d,T,t}$ is their total profits, $\pi_{d,t}^*$ (\(\pi_{d,t}^*\) ) profits of the capital invested domestically (abroad).

\(^{24}\)According 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.

\(^{25}\)As described above, $A_0$ of expatriated firms is national (\(A_{d,0}\) ) and $g_A$ local (\(g_{A_f}\) ).

\(^{26}\)For example $Y_{d,t}^*$ and the dynamic of expatriated capital become $y_{d,t}^* = Y_{d,t}^* / A_{f,t}$ and $k_{d,t}^* = (1 - \delta_{f}) k_{d,t-1}^* A_{f,t-1} + i_{d,t}^* / A_{f,t}$, with $A_{f,t} = (1 + g_{A_f}) A_{d,0}$ for expatriated firms. See the details in the appendix.

\(^{27}\)This higher depreciation captures corruption (Angang (2001, 2002)), excessive dividends distribution (Lee and Xiao (2003)), the lack of property rights protection (Ju and Wei (2010)), among other things.
firms is the addition of households domestic savings and financial capital inflows (foreign bonds purchases from foreign households):

\[ D_{d,t} = B_{d,t} + B_{f,t}^* \]  

Then the capital borrowed is proportionally distributed between domestic and expatriated foreign capital:

\[ D_{d,t} = \left( \frac{K_{d,t-1}}{K_{d,t-1} + K_{f,t-1}} \right) D_{d,t} \] and \[ D_{f,t}^* = \left( \frac{K_{f,t-1}^*}{K_{d,t-1} + K_{f,t-1}^*} \right) D_{d,t} \]. Frictions on the credit market are introduced so that firms face borrowing constraints \( \zeta \), that limit the amount of capital they can bring as collateral:

\[ B_{d,t} = \zeta_d \left( K_{d,t-1} + K_{f,t-1}^* \right) \]  

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 and al. (2011), Coeurdacier and al. (2012), among others). A tighter (resp. looser) credit constraint is set in the country with a higher (resp. lower) moral hazard. It is assumed that the collateral constraint on firms’ borrowing is enforced \textit{ex-ante} and not \textit{ex-post} (so depending on capital available at time \( t-1 \) and not at \( t \)).

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

Under this assumption, incomes on savings

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

are added to firms’ profits. Moreover, as financial capital from private Chinese firms is now financing

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28To bypass these credit constraints some private firms use FDI (see Hericourt and Poncet (2008)) or the shadow banking (see Krugman (2011), Tsai (2002)). It can not be modeled here as the model is already heavy.

29One possible extension could be an endogenous credit constraint depending on moral hazard, or vice versa. Such an extension is however difficult to solve technically, and the present model is already quite large.

30The major part of SOE profits disappear with corruption and excessive dividends distribution (Xiao and Kimball (2006)). The minor part of their savings is invested in production (Song and al. (2011)), but it is considered as nil here.

31For instance total profits of domestic firms become:

\[ \pi_{d,t} = Y_{d,t} + \varepsilon_t Y_{d,t}^* + D_{d,t} - (1 + \tau_d) \left( 1 - \gamma_d \right) D_{d,t-1} + \varepsilon_t D^*_{d,t} - \varepsilon_t \left( 1 + r_{f,t} \right) \left( 1 - \gamma_f \right) D^*_{f,t-1} - (W_{d,t}N_{d,t} + I_{d,t}) - \varepsilon_t (W_{d,t}^*N_{d,t}^* + I_{d,t}^*) + IC_{d,t} \]

with \( IC_{d} \) incomes on savings: \( IC_{d} = r_{f,t-1} \left( 1 - \gamma_f \right) \pi_{d,t-1}^* - \frac{X_d}{1 + \mu_d} \left( \pi_{d,t} - \pi_{d,t-1} \right)^{1+\mu_d} \) and \( \pi_{d,t-1} \) profits of non-expatriated domestic capital at the previous period (\( \pi_{d,t} = Y_{d,t} + D_{d,t} - (1 + \tau_d) \left( 1 - \gamma_d \right) D_{d,t-1} - (W_{d,t}N_{d,t} + I_{d,t}) \)). The share of Chinese firms expatriated abroad (\( d^* \)) does not have incomes on savings as the assumption is valid only in China.

The incomes of U.S. expatriated firms in China are included in \( \pi_{f,T,t} \). Foreign firms’ profits become:

\[ \pi_{f,T,t} = \pi_{f,t} + \pi_{f,t}^* = Y_{f,t} + Y_{f,t}^* + D_{f,t} - (1 + \tau_f) \left( 1 - \gamma_f \right) D_{f,t-1} + \varepsilon_t D^*_{f,t} - \varepsilon_t \left( 1 + r_{f,t} \right) \left( 1 - \gamma_f \right) D^*_{f,t-1} - (W_{f,t}N_{f,t} + I_{f,t}) - \varepsilon_t (W_{f,t}^*N_{f,t}^* + I_{f,t}^*) + IC_{f,t}^* \]

with \( IC_{f,t}^* = r_{f,t-1} \left( 1 - \gamma_f \right) \pi_{f,t-1}^* - \frac{X_d}{1 + \mu_d} \left( \pi_{f,t}^* - \pi_{f,t-1}^* \right)^{1+\mu_d} \).

32Furthermore, it might be precised that firms’ program is not solve against the \( \pi_{d,t} \) that takes into account 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 do not get in the optimization.
firms located in U.S., aggregate deposits in the foreign country become:

\[ D_{f,T,t} = \text{domestic bonds + financial capital inflows} \]

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

First order conditions imply:

\[ (1 - \alpha_d) \frac{Y_{d,t}}{N_{d,t}} = W_{d,t} \]  

\[ (1 - \alpha_f) \frac{Y_{d,t}^*}{N_{d,t}^*} = W_{d,t}^* \]  

\[ E_t \left[ \frac{\lambda_{d,t+1}}{\lambda_{d,t}} \left( 1 - \delta_d + \alpha_d \frac{Y_{d,t+1}^*}{K_{d,t}} - (1 + r_{d,t}) (1 - \gamma_d) \right) \right] = 0 \]  

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

Equations (17)-(18) are standard labor demands and Equations (19)-(20) 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 \(1 - \delta_f + \alpha_d \frac{Y_{d,t+1}^*}{K_{d,t}^*} - (1 + r_{f,t}) (1 - \gamma_f)\) is larger than \(1 - \delta_d + \alpha_d \frac{Y_{d,t+1}}{K_{d,t}} - (1 + r_{d,t}) (1 - \gamma_d)\).

Foreign firms solve the same problem with similar equations. Even under the assumption that \(B_{d,t}^* = 0\), firms in the foreign country are indebted to domestic country (financial capital inflows in Equation (17)).

### 3.3 Aggregation

Labor market clearing conditions are straightforward (already implicitly imbedded in the households section).

National GDP in each country is defined as:

\[ GDP_{d,t} = Y_{d,t} + Y_{d,t}^* \]  

\[ = C_{d,t} + I_{d,t} + I_{f,t}^* + \frac{X_d}{1 + \mu_d} \left[ (B_{d,t}^* - B_{d,t-1}^*)^{1+\mu_d} + (\pi_{d,t} - \pi_{d,t-1})^{1+\mu_d} + (\pi_{f,t}^* - \pi_{f,t-1})^{1+\mu_d} \right] \]

\[ GDP_{f,t} = Y_{f,t} + Y_{d,t}^* \]  

\[ = C_{f,t} + I_{f,t} + I_{d,t}^* + \frac{X_f}{1 + \mu_f} \left[ (B_{f,t}^* - B_{f,t-1}^*)^{1+\mu_f} \right] \]

\[ 33\text{Labor supply in the domestic country is (}N_{d,t} + N_{d,t}^*), and (}N_{f,t} + N_{d,t}^*\text{) in the foreign country.} \]
The clearing conditions on goods markets is the aggregation of domestic and foreign GDP:

\[
GDP_{d,t} + GDP_{f,t} = C_{d,t} + C_{f,t} + I_{d,t} + I_{f,t} + I^*_d + \frac{\chi_f}{1 + \mu_f} (B^*_{f,t} - B^*_{f,t-1})^{1+\mu_f} + \frac{\chi_d}{1 + \mu_d} \left[ (B^*_{d,t} - B^*_{d,t-1})^{1+\mu_d} + (\pi_{d,t} - \pi_{d,t-1})^{1+\mu_d} + (\pi^*_{f,t} - \pi^*_{f,t-1})^{1+\mu_d} \right]
\]

As mentioned in the firms’ subsection, bonds market clearing conditions are the total deposits available in each country:

\[
D_{d,t} = B_{d,t} + B^*_{f,t} \\
D_{f,t} = B_{f,t} + B^*_{d,t} + \pi_{d,t} + \pi^*_{f,t}
\]

Similarly 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. Each type of firm has a share \( s \) of employment in the total of firms; it is fixed in the steady state but evolves endogeneously after (for more details see the calibration section). It corresponds to the share of SOE (see the next subsection) and FDI-in/out (coefficients \( \eta_{Soe}, \omega_{in} \) and \( \omega_{out} \)). 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:

\[
\begin{align*}
\{ & \, C_{d,t}, C_{f,t}, B_{d,t}, B^*_{d,t}, B_{f,t}, B^*_{f,t}, r_{d,t}, r_{f,t}, W_{d,t}, W^*_{d,t}, W_{f,t}, W^*_{f,t}, W_{S,t}, N_{d,t}, N^*_{d,t}, N_{f,t}, N^*_{f,t}, N_{S,t} \} \quad \infty \\
\{ & \, Y_{d,t}, Y^*_{d,t}, Y_{S,t}, Y_{f,t}, Y^*_{f,t}, K_{d,t}, K^*_{d,t}, K_{f,t}, K^*_{f,t}, I_{d,t}, I^*_{d,t}, I_{S,t}, I_{f,t}, I^*_{f,t} \} \\
\end{align*}
\]

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

\[
NFA_{d,t} = (B^*_{d,t} - \pi_{d,t} - \pi^*_{f,t}) - B^*_{f,t} + I^*_{d,t} - I^*_{f,t}
\]

\[
= \alpha_d Y^*_{d,t} - \alpha_f Y^*_{f,t} + (1 + r_{f,t}) (1 - \gamma_f) (B^*_{d,t-1} + \pi_{d,t-1} + \pi^*_{f,t-1}) - (1 + r_{d,t}) (1 - \gamma_d) B^*_{f,t-1} - \frac{\chi_d}{1 + \mu_d} \left[ (B^*_{d,t} - B^*_{d,t-1})^{1+\mu_d} + (\pi_{d,t} - \pi_{d,t-1})^{1+\mu_d} + (\pi^*_{f,t} - \pi^*_{f,t-1})^{1+\mu_d} \right] + \frac{\chi_f}{1 + \mu_f} (B^*_{f,t} - B^*_{f,t-1})^{1+\mu_f}
\]

\[
NFA_{f,t} = (B^*_{f,t} - \pi_{f,t} - \pi^*_{d,t}) - B^*_{d,t} + I^*_{f,t} - I^*_{d,t}
\]

\[
= \alpha_f Y^*_{f,t} - \alpha_d Y^*_{d,t} + (1 + r_{d,t}) (1 - \gamma_d) (B^*_{f,t-1} + \pi_{f,t-1} + \pi^*_{d,t-1}) - (1 + r_{f,t}) (1 - \gamma_f) B^*_{d,t-1} - \frac{\chi_f}{1 + \mu_f} \left[ (B^*_{f,t} - B^*_{f,t-1})^{1+\mu_f} + (\pi_{f,t} - \pi_{f,t-1})^{1+\mu_f} + (\pi^*_{d,t} - \pi^*_{d,t-1})^{1+\mu_f} \right] + \frac{\chi_d}{1 + \mu_d} (B^*_{d,t} - B^*_{d,t-1})^{1+\mu_d}
\]

\[
\]
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:

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

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 (SOE)

SOE 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). SOE are intensive in capital and have high investment rates due to a better access to credit than private firms. However SOE have a lower productivity, what mainly explains why profits are low (see Figure 16 in Appendix). Corruption and excessive dividends distribution further low productivity and returns on capital.

An exogenous share of employment in SOE \( \eta_{Soe} \) is assumed in the economy: the domestic labor force is attributed in priority to SOE by the government. The rest goes to private firms.

SOE do not expatriate capital abroad and maximize their profit in the same way than private firms:

\[
\max_{\beta} E_0 \sum_{t=0}^{\infty} \beta^t \lambda_{d,t} \pi_{S,t}
\]

where

\[
\pi_{S,t} = D_{S,t} + Y_{S,t} - (1 + r_{d,t}) (1 - \gamma_d) D_{S,t-1} - (W_{S,t} N_{S,t} + I_{S,t})
\]

with \( D_{S,t} = B_{S,t} = \zeta_{Soe} (K_{d,t-1} + K^*_{d,t-1} + K_{S,t-1}) \). As private firms in China, SOE 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 \( \zeta \)), 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 and al. (2011), and China Fixed Asset Investment Statistical Yearbook), it is supposed that SOE do not grow their profits through foreign assets as domestic banks provide them all the required liquidity. Domestic labor force still have the choice to work either in domestic private firms or in expatriated foreign firms. Now households have the choice to invest their savings in domestic private bonds, bonds issued by SOE, or foreign bonds. Thus the welfare
The risk aversion parameter \( \sigma \) balanced growth. The parameters of households' preferences and firms' production are calibrated to have \( \psi \) A higher 

34 households' savings. However, with the utility function used there is a high margin for wealth effect. \( \beta \) The calibration is classic for the discount rate 

4.1 Households will adjust along the way. All is summarized in the Table 1.

are done under high TFP growth. Some parameters will remain fixed over time while other parameters from high to low capital controls (financial liberalization). These economic and financial liberalizations from a transition of the Chinese economy from a high to low share of SOE (economic liberalization), and capital flows, investments/savings, and consumption over the last thirty years in China. It will result The model is annual. The main objective of this calibration exercise is to reproduce the dynamics of 

4 Calibration and data

The current account becomes:

\[
CA_{d,t} = TB_{d,t} + NIC_{d,t} = Y_{d,t} + Y_{f,t} + Y_{S,t} - C_{d,t} - I_{d,t} - I_{S,t} - I_{f,t} + r_f (1 - \gamma_f) (B_{d,t-1}^* + \pi_{d,t} + \pi_{f,t}) - r_d (1 - \gamma_d) B_{f,t-1}^* + \frac{\chi_f}{1 + \mu_f} (B_{f,t}^* - B_{f,t-1}^*)^{1 + \mu_f} - \frac{\chi_d}{1 + \mu_d} \left( (B_{d,t}^* - B_{d,t-1}^*)^{1 + \mu_d} + (\pi_{d,t} - \pi_{d,t-1})^{1 + \mu_d} + (\pi_{f,t} - \pi_{f,t-1})^{1 + \mu_d} \right)
\]  

(34)

4.1 Households

The calibration is classic for the discount rate \( \beta \) (0.97). It should be higher in China in order to raise households’ savings. However, with the utility function used there is a high margin for wealth effect.34 A higher \( \psi \) in China is used to have a fraction of time spent working close to 0.6 (0.4 for the U.S.). The risk aversion parameter \( \sigma \) 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

34In this case, with a rise in the discount rate the present discounted value of incomes at next period would rise, so substitution effect and precautionary savings would decrease. In an extension an other utility function could decrease the wealth effect so as to have different discount rates impacting even more households’ savings. However, the model remains more unstable with this kind of utility function, so the first one detailed in households’ subsection is preferred.
lower wages in China against the U.S., that for all types of firms: private (domestic and expatriated from abroad) and SOE.

4.2 Firms

The capital share in production is higher in the United States and SOE, as private firms in China are labor intensive (whereas capital intensive in U.S. and SOE). Parameters $\alpha$ and $\delta$ are fixed to match the data for the marginal return on capital $r + \delta = \alpha \frac{Y}{K} (1 + g_A)$ in the 1980s. A higher $\delta$ in China captures capital expropriation. According to Angang (2001, 2002) different types of corruption lead to economic losses of approximately 13.3-16.9% in average in the late 1990s. It is more frequent in SOE than in private firms: $\delta_{S, \delta_d}$, and $\delta_f$ are respectively set to 0.15, 0.12, and 0.08. Hence, shares of capital in production are fixed at 0.18 in China and 0.3 in U.S. to reproduce capital intensiveness patterns and marginal returns on capital. TFP growth is calibrated to the 80’s in the first periods of the model and adjusts gradually over time to reach TFP growth observed in the 2010’s. For SOE (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. So $A_{d,0}$ is calibrated at 1.06 and $A_{f,0}$ at 1.5. The share of employment in SOE, $\eta_{SOE}$, is initially set to 0.75; that is, at the beginning of the liberalization of 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 and al. (2011).

4.3 Credit market

Credit constraints have a calibration close to Coeurdacier and al. (2012). They are tight for private Chinese firms ($\zeta_d = 0.02$ initially) while looser for SOE and U.S. private firms ($\zeta_{S,f} = 0.2$ initially). For simplicity, at the beginning of the transition credit constraints of SOE are regarded to be similar to U.S. ones. 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. $\gamma_f$ is set at 1%. Concerning capital controls in China, they are far from being

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

Source: World bank (World Development Indicators).

The data concerning the share of employment in SOE 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 SOE 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 SOE would be consequently lower in an adjusted data. (iii) If $\eta_{SOE}$ is initially set at 85% in this model, and if its path ends at 45% and not 40%, the path of some variables as $B_{d,t}$ or $C_{A,t}$ is shifted downward mainly at the beginning of transition. It means the the final level of foreign assets and current account (for example) is nearly reached as in the previous calibration, but the first values are too low. What matters most is the end of the transition and not the beginning, having too low first values discomforts the reading of the last important values and remains incoherent (for example the current account would be initially at -15%).
only simple costs on bonds (Xiao and Kimball (2006)). 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 ($\varphi Y = \frac{\text{output}_{d,t}}{\text{output}_{d,t} + \text{output}_{f,t}} = 0.05$). Then it evolves endogenously. The shares of expatriated and local firms in China and the U.S. ($\omega_{in}$, $\omega_{out}$, $1 - \omega_{out}$, and $1 - \omega_{in}$) are set to match FDI-to-GDP ratios at the beginning of the transition. Then it also evolves endogenously. As for SOE, it is already mentioned that it gradually goes from $\eta_{S oe} = 75\%$ to $40\%$ over the transition. Thus labor supply, marginal consumption, trading costs, and market clearing conditions become:

$$
\Phi \left[ \frac{N_{d,t}}{(1 - \eta_{S oe}) \varphi Y (1 - \omega_{in})} \right] = W_{d,t}
$$

$$
\Phi \left[ \frac{N_{f,t}}{(1 - \eta_{S oe}) \varphi Y \omega_{in}} \right] = W_{f,t}
$$

$$
\Phi \left[ \frac{N_{S,t}}{\eta_{S oe}\varphi Y (1 - \omega_{in})} \right] = W_{S,t}
$$

$$
\Phi \left[ \frac{N_{d,t}}{(1 - \varphi Y) (1 - \omega_{out})} \right] = W_{d,t}
$$

39 However, Chinese financial integration is more complex. There are different limited amounts and taxes depending on the direction and type of financial flows. And it is varying during the transition. According to Xiao and Kimball (2006) and Annual Report of Exchange Arrangements and Exchange Restrictions (AREAER), a lot of 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, 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.
\[ C_{d,t} + \frac{\varepsilon_t}{\varepsilon_{t+1}} \left[ 1 + \chi_d \left( \frac{B_{d,t}}{\theta Y} - \frac{B_{d,t-1}}{\theta Y} \right)^{1+\mu_d} \right] + \left( \frac{\pi_{d,t}}{\theta Y} - \frac{\pi_{d,t-1}}{\theta Y} \right)^{1+\mu_d} \left( \frac{\pi_{f,t}}{\theta Y} - \frac{\pi_{f,t-1}}{\theta Y} \right)^{1+\mu_f} \]
\[ = \lambda_{d,t} \]
\[ C_{f,t} + \frac{1}{1-\theta Y} \left[ 1 + \chi_f \left( \frac{B_{f,t}}{\theta Y} - \frac{B_{f,t-1}}{\theta Y} \right)^{1+\mu_d} \right] + \left( \frac{\pi_{d,t}}{\theta Y} - \frac{\pi_{d,t-1}}{\theta Y} \right)^{1+\mu_d} \left( \frac{\pi_{f,t}}{\theta Y} - \frac{\pi_{f,t-1}}{\theta Y} \right)^{1+\mu_f} \]
\[ = \lambda_{f,t} \]

4.5 Forces driving the transition

The model replicates the Chinese transition from low to high growth using TFP growth. So in particular a deterministic shock of the TFP growth rate is set during 35 years in Chinese private firms. It goes 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 data by: (i) an economic liberalization that is captured by having gradually a lower share of SOE (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 (\( \zeta_{d/d^*} \) goes up to 24% of capital, and \( \zeta_{SOE} \) to 70%) (iv) by an increase in the capital to output ratio, captured by having a higher \( \alpha \) over time (from 0.17 to 0.30).
Table 1: Calibration of the benchmark model

<table>
<thead>
<tr>
<th>Parameters</th>
<th>China</th>
<th>U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Constant parameters</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\beta$ discount rate</td>
<td>0.97</td>
<td>0.97</td>
</tr>
<tr>
<td>$\sigma$ intertemporal elasticity of substitution</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>$\psi$ inverse of Frisch elasticity</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>$\mu$ curvature of bonds trading costs</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>$A_0$ initial technology</td>
<td>1.06</td>
<td>1.5</td>
</tr>
<tr>
<td>$\delta$ capital depreciation rate</td>
<td>0.12 for private firms</td>
<td>0.08</td>
</tr>
<tr>
<td>(capital expropriation)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\gamma$ moral hazard (ratio of defaulting loans)</td>
<td>0.12</td>
<td>0.01</td>
</tr>
<tr>
<td>$\phi_Y$ initial share of output</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>$\omega_{in}$ initial share of FDI-in</td>
<td>0.007</td>
<td></td>
</tr>
<tr>
<td>$\omega_{out}$ initial share of FDI-out</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td><strong>Economic liberalization</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\eta_{SOE}$ share of SOE</td>
<td>0.75 down to 0.4</td>
<td>0</td>
</tr>
<tr>
<td><strong>Financial liberalization</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\chi$ bonds trading costs</td>
<td>0.4 down to 0.02</td>
<td>0 ($B_f^* = 0$)</td>
</tr>
<tr>
<td><strong>Financial development</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\zeta$ credit constraint</td>
<td>0.02 up to 0.24 for private firms</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>0.2 up to 0.7 for SOE</td>
<td></td>
</tr>
<tr>
<td><strong>Transition</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$gA$ TFP growth</td>
<td>0.01 up to 0.045 for private firms</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>0.007 for SOE</td>
<td></td>
</tr>
<tr>
<td>$\alpha$ share of capital in production</td>
<td>0.17 up to 0.3 for private firms</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>0.17 for SOE</td>
<td></td>
</tr>
</tbody>
</table>

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 2. 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 these variables are expressed in percentage of GDP. Note that for the data of trade balance and FDI-in/out, China and U.S. are considered as the sole partners: it is not against the rest of the world.

Table 2: Results (% GDP) - China

<table>
<thead>
<tr>
<th>Variables (% GDP)</th>
<th>Middle of 1980s</th>
<th>Middle of 1990s</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model</td>
<td>Data</td>
<td>Model</td>
</tr>
<tr>
<td>Current account</td>
<td>−3.3</td>
<td>0</td>
<td>8.8</td>
</tr>
<tr>
<td>Trade balance</td>
<td>−2.5</td>
<td>−0.25</td>
<td>8.9</td>
</tr>
<tr>
<td>Foreign assets</td>
<td>−26.7</td>
<td>4.6</td>
<td>3.5</td>
</tr>
<tr>
<td>FDI-in</td>
<td>6.3</td>
<td>1.15</td>
<td>10.3</td>
</tr>
<tr>
<td>FDI-out</td>
<td>1.4</td>
<td>0.08</td>
<td>2</td>
</tr>
<tr>
<td>Consumption</td>
<td>61.9</td>
<td>76.2</td>
<td>50.1</td>
</tr>
<tr>
<td>Aggregate saving rate</td>
<td>−4.4</td>
<td>35.7</td>
<td>22.1</td>
</tr>
<tr>
<td>Aggregate investment rate</td>
<td>32</td>
<td>35</td>
<td>44</td>
</tr>
</tbody>
</table>

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, SOE have a large access to credit and their share is initially very large: the major part of households savings goes to SOE bonds. Moreover, as the foreign interest rate is lower they borrow abroad to maintain their initial high level of consumption. Then, foreign assets become positive as in the data. The next section explains it in the details but it mainly results from the combination of different elements: the growing share of private firms (impacting firms and households savings), the decrease in trading costs, and the high level of moral hazard and capital expropriation. These elements explain the growing level of foreign assets only under a higher TFP growth over time.
Figure 5: Results (% GDP) - China
Regarding FDI, inflows (panel (c)) are growing contrary to outflows (panel (d)). The main explanation is a high (low) TFP growth and low (resp. high) wages in China (resp. in the U.S.), attracting expatriated 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, notice that starting in 2000, their increase is slowed down (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 the more surprising since wages of expatriated firms have a larger growth rate than domestic and U.S. wages (Figure 9). 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 in the end of 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 of FDI against GDP it is important to remind that China and U.S. are considered as 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).

![Figure 6: Firms’ profits (% GDP of each firm) - China](image)

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, mpK/returns on bonds. The global explanation is that there are credit market frictions and capital losses under high TFP growth, which raise the aggregate saving rate during economic and financial liberalization. Financial imperfections lower the returns on bonds, and the mpK is increasing with the growing share of labor intensive and productive firms. All these mechanisms

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40 In 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 decrease, it is due to a higher growth path of GDP in China compared to its capital located in U.S..

41 Source: OECD data
are detailed in the sensitivity section.

The aggregate saving rate is nearly equally shared by households and firms at the end of the transition (Figure 8). It is consistent with the data of the last fifteen years, and with some works as Bayoumi, Tong, and Wei (2010), Ma and Wang (2010), ... Although households saving rate becomes closer to the data in the last years, it remains too high in the model in the middle of the transition. It is mainly due to inadequate capital controls, and because some determinants of households savings are lacking. Note that households aggregate saving rate is $S_{Hd} = B_{d}^* + B_d + B_S$, and firms one $S_{Fd} = \pi_d + \pi_f$. 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 7). Only the amount of foreign bonds purchase by households remains.

Figure 7: Foreign assets without firms profits (% GDP) - China

Model and data

Data

Figure 8: Saving rates (% GDP) - China

As for consumption in China, its decrease in the model is mainly due to financial development: credit constraints are progressively relaxed, driving households wealth to savings (through domestic bonds) instead of consumption. There are also other determinants of households savings and consumption in China. The level of foreign interest rates (higher than in China) and decreasing trading costs increase

\footnote{For example, the bad quality of social insurance, pension system, property rights protection, among others.}
households savings. In the model, the rising share of labor intensive firms largely raises the time households spend at work, with low wages which also decreases their consumption. However, in the data this decrease in consumption is mainly due to the bad quality of social insurance, pension system, or property rights protection, among other determinants. These elements are not taken into account in the model. They could raise the propensity to save under a risky framework. As for U.S. consumption and savings, they do not fit well the data (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 U.S. indebted to China. This would raise the level of consumption and reduce savings in the U.S., getting closer to the data. However, relaxing this assumption would uselessly complexify 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 output surge and to investment restrictions for private firms. In the late 1990s the current account exceeds the trade balance. It is because China is not indebted to the U.S. anymore, and there is a fast rise of returns on foreign bonds. As the magnitude of trading costs \( \chi_d \) decreases progressively, net income drives the current account up to a level close to 10 % of GDP at the end of the transition:

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

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

After 2007, financial development in China reaches a level (credit constraints progressively relaxed) at which investment growth becomes higher than output growth, slowing down 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 households’ savings more massively towards domestic bonds, reducing their purchases of foreign bonds.

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 frictions and assumptions are removed and the resulting dynamics are compared to the benchmark.
5 Sensitivity

5.1 SOE and trading costs: the economic and financial liberalization

In the model, the economic liberalization means a decrease in the share of employment in SOE $\eta_{SOE}$ 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 comparing the benchmark with equilibria where both assumptions are relaxed. Before going into more details, some key points about the impact of liberalization on the results (Figure 10) might be summarized. First, under heterogeneous credit constraints and TFP growth among firms, the transition from SOE to private firms is the key element creating external surpluses. Indeed, the share of private labor intensive firms is growing. Their low access to credit slows down their investments, but, with a high TFP growth, they make profits and save them abroad. It creates large foreign assets and current account surpluses, in line with Song and al. (2011). 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 have a high growth rate. In particular, TFP growth and low labor costs (Figure 9) attract them. 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. Lower capital controls make savings in foreign bonds more attractive, the loosening of credit constraints in SOE and private firms raises households savings, and households spend more time working to the detriment of leisure with the rising share of labor intensive firms. These elements make consumption decrease during the transition.

We now describe the effects of the economic liberalization on each variable, starting with foreign assets. The share of SOE in the economy crucially affects both households and firms savings, building up external surpluses. This effect is just magnified by the financial liberalization. Both effects appear clearly in Figure 10 (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 SOE is very large. The assumption of a large share of SOE is equivalent to low global credit constraints in China, as $\zeta_{SOE} > \zeta_d/\delta$. Households share their savings between domestic SOE bonds $B_S$ and foreign bonds. With low credit constraints the former meets the demand for savings from households; the latter is determined by the trade-off between domestic and foreign bonds (Equation 7). As the foreign interest rate is low and capital controls are high, they borrow abroad in order to maintain their high initial level of consumption. In the benchmark, global borrowing constraints are tightened with the falling share of SOE. Domestic bonds are not sufficient to collect savings, that is why households turn to foreign bonds. This opportunity of foreign bonds purchase is improved by lower capital controls across time and higher TFP growth. Indeed, with financial integration, foreign assets rise quicker and reach a higher level (Figure 10, panel (a)). Notice 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
Figure 10: The impact of economic and financial liberalization (the share of employment in SOE and capital controls), results in % GDP - China
amount firms can borrow, amount globally attributed to SOE. 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 want (with high returns), the external surplus would be somehow smaller.

As for firms savings, SOE are capital intensive with low productivity, against high productivity and labor intensiveness in private firms. In the benchmark, profits become higher in the latter (Figure 6 (16 for data)), and these new savings tend to be invested abroad. This mechanism is amplified over time with the rising share of SOE and the 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 SOE is therefore the main reform explaining capital misallocation, as in Song and al. (2010). Households savings are driven to SOE, and financial integration overcomes the lack of capital in private firms with foreign financing through savings (as in Benhima (2013a)).

The dynamics of the current account is reversed without economic and financial liberalizations (Figure 10, panel (b)). Indeed, a constant and high rate of well financed SOE promotes a growth based on imports and domestic investments. Thus, the aggregate investment rate rises faster at the end of the transition (Figure 10, panel (f)), but the gain in GDP remains low as SOE’s TFP growth is not as high as in 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 via net income is quantitatively important, but does not drive it qualitatively. Moreover, consumption also tends to raise the deficit of the current account when there is no privatization (Figure 10, panel (g)). If the share of SOE remains high during all the transition, consumption rises. As a matter of fact, households do not spend a lot of time working in private and labor intensive firms with low wages, so they consume more. This effect is strong in the model as it overturns the increase in households savings to SOE bonds. Like the other variables, the effect of economic liberalization on consumption is just amplified by the financial liberalization.

Regarding FDI, the decrease in the share of SOE obviously raises (resp. reduces) inflows (resp. outflows) with the opportunity for private firms to invest with high TFP growth (Figure 10, panels (c) and (d)). The growth rate of FDI-in is slowed-down by growing wages, but they remain attractive with high TFP

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43 Remind 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 it abroad is realistic.

44 Remind that SOE have credit constraints which are more looser overtime than private firms. Thus, if the share of SOE remains constants, it directly raises further households savings to SOE bonds compared to the case under firms privatization. It is due to Equation (7) which is not a real trade-off. First the amount of domestic bonds purchase by households is attributed by credit constraints and the capital accumulation of firms, then households choose their amount of foreign bonds.

45 In terms of stock amount (not relatively 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 decrease, it is due to a higher growth path of GDP in China compared to its capital located in U.S..
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 expatriated firms.

5.2 Credit market frictions

We now comment the specific effects of credit market frictions. Figure 11 contrasts the respective contribution of credit constraints and moral hazard (the ratio of defaulting loans), by removing one of the assumption or both assumptions together. Looser credit constraints for private firms means an increase in the capacity to borrow $\zeta_d$ from 0.2 to 0.4 against 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 down the growth rate of domestic investments (Figure 11, panels (e) and (f)), in line with the literature on global imbalances. Moreover, as in Song and al. (2011) heterogeneous credit constraints make SOE be capital intensive (due to a better access to credit), and private firms labor intensive. The decreasing share of SOE 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 11, 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. So the latter raise financial capital outflows. Moreover, such a credit market friction also increases foreign investments of private domestic firms (FDI-out in Figure 11, panel (d)). Thus, when credit constraints become looser, it is obvious that the aggregate saving rate, financial capital outflows, the current account, and FDI-out are reduced, and that the domestic investment rate increases (Figure 11). These looser credit constraints also decrease slightly FDI inflows, because they raise wages in foreign firms in China (Figure 12). One issue with this high share of labor intensive firms is the rise in wages due to financial development: it decreases FDI-inflows, so maintains a large external surplus even if foreign assets start decreasing ($NFA_{d,t} = B_{d} + \pi_d + \pi_f - B_f + I_d - I_f$). That is why a rise in financial development would not be a solution to largely reduce global imbalances, as mentionned by Martin and Ventura (2012). Looser credit constraints impact negatively consumption in the model, as it raises savings to domestic bonds (Figure 11, panel (g)). Indeed, firms can borrow a larger amount of capital, which is directly taken from households savings.

As for 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 households to buy them through the trade-off (Equation 7). Second, higher moral hazard in China raises financial capital outflows because it discourages to invest in domestic private firms or through FDI (Figure 11, panels (c) and (f)), as in Ju and Wei (2010). Indeed, there is a surge in domestic real interest rate under

46In steady state wages in China are of course lower than U.S. ones under this calibration; more precisely, those in foreign expatriated firms are higher than domestic private ones and SOE: $W_{SS0} = (1-\alpha)A_0 \left[ \frac{g_A + g_f}{\alpha(1+g_A)} \right] ^{\alpha-1}$ (the proof is in the appendix). Indeed, $\alpha_f > g_A_{SOE}, \alpha_f > A_0, g_f$, and $g_A_f > g_A_f$; so 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.
Figure 11: The impact of credit market frictions (credit constraints and moral hazard), results in % GDP - China
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. Trading off physical and financial capital (Equation 7), less productive firms can not invest. In addition, moral hazard raises corporate savings at the end of the transition, so financial capital outflows and the current account too (Figure 11, panels (a) and (b)). When the assumption that moral hazard is high in China is relaxed, Figure 11 shows an increase in FDI-in, firms investments, and capital accumulation. The latter raises the amount firms can borrow, so households savings too, and consumption decreases. These combined effects result in reduced net foreign assets. However, lower moral hazard decreases firms expatriation to U.S.. Indeed, the high level of moral hazard in the benchmark model discouraged firms to invest domestically (i.e. in China), rising they share of capital expatriated (i.e. in the U.S.). The observed decrease in 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.\footnote{It extends the result of Martin and Taddei (2013) to moral hazard instead of adverse selection. In their paper, adverse selection and limited pledgeability are the two credit market frictions at the origin of capital outflows, one friction amplifying the effect of the other.} 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. It is the same for the saving rate. Regarding FDI-in, they are 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. The adjustment pattern of the current account is affected similarly. Indeed, low moral hazard increases the current account, and looser credit constraints produce deficits.\footnote{For the rise in the current account with low moral hazard, it comes from higher investments in high productive firms. The trade balance increases as the output growth rate is higher than investments growth rate. The increase in the current account does not come from larger net income, as returns on foreign bonds are impacted by foreign moral hazard.} However, there is a large drop in the current account when the two credit market frictions are relaxed. As for consumption, it increases when the assumption of two high credit market frictions is relaxed, while it decreases when the two frictions are separately relaxed. Looser credit constraints raise savings to domestic bonds, and a lower ratio of defaulting loans also makes returns on domestic bonds become higher. In the model wealth effect dominates, so savings abroad are reduced. Chinese households become indebted against U.S., and their consumption increases.
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.\textsuperscript{49} When the calibration of these parameters is adapted to Chinese case, both assumptions amplify financial capital outflows and global imbalances (Figure 13, panel (a)). Indeed, a lower capital share and a higher depreciation rate of capital decrease returns on investments, so raise corporate saving 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 saving rate invested abroad.

As explained in the previous sections, the depreciation of capital $\delta$ is a proxy for capital expropriation in the model. In this context it captures all the structural imperfections leading to losses in capital: corruption, weak property rights protection, and an excessive dividends distribution. Its role is similar to the coefficient in front of returns on investments in the static model of Ju and We (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 and excessive dividend distribution are mainly present in SOE (high $\delta_S$). In Chinese private firms, $\delta_d$ 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 14) and financial capital outflows (Figure 13, panel \textsuperscript{49}Indeed, as for the share of capital in production, in the papers with a Cobb-Douglas production the calibration maintains $\alpha$ at a high value. In fact, the labor share observed in the data decreased during the transition (Bai, Chong-En, and Zhenjie Qian (2009)): its initial high value compared to capital share contributed to the rising corporate saving rate in China. Regarding capital expropriation in the literature of global imbalances, only Ju and Wei (2010) take it into account, and 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 done through the law of motion of capital and its depreciation rate, as is the case here.

\textsuperscript{31}
Figure 13: The impact of capital expropriation and the share of capital in production, results in % GDP - China
(a)), and increases the investment rate (Figure 13, panel (f)). Note that the aggregate saving rate (Figure 13, panel (e)) rises slightly when capital expropriation is low. The latter decreases corporate saving rate (Figure 14) but increases households savings. Indeed, there is more capital accumulation under low capital expropriation, which increases the amount firms can borrow. It directly raises the purchase 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 13, 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 13, 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 domestic bonds by households rise, and consumption falls.\(^50\)

Regarding the share of capital in production \(\alpha\), its value determines if a firm is intensive in labor or in capital. The benchmark calibration sets a low (high) \(\alpha\) in China (U.S.). Its impact is similar to that of capital productivity: when the capital is well allocated and goes 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. However, it 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.\(^51\) The impacts of TFP growth are conditional on a small capital share in China. Indeed, the contribution of Chinese TFP growth in capital flows patterns is based on the labor intensiveness of private firms due to the economic liberalization. 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).

\[\text{Figure 14: Firms’ savings (% GDP) - China}\]

\(^50\) However, this consumption behavior is not very realistic, as it is too much linked to firms capital accumulation. In "reality", lower capital losses for firms impacts households 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 to the detriment of foreign ones. Moreover, the household saving rate should also be especially function of other structural elements, as the quality of pensions systems, social insurance, the demographic growth, ... These elements should drive households savings, and have a larger impact on consumption than the impact of domestic bonds due to lower capital expropriation.

\(^51\) Indeed, the capital share remains national in expatriated firms. If it was not the case, the reaction of FDI-in/out to a higher capital share in China would be reversed.
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, combined with credit market frictions (interacting with each other), matter the most to solve the capital misallocation. The financial liberalization amplifies the movement in financial capital and FDI, while expropriation and capital intensiveness matter to get the right levels compared to the data.

6 Conclusion

This study sheds on light the issues an emerging country privatizing can encounter. Indeed, when the public sector doesn’t assist enough the growing private one, in addition to others credit and capital markets frictions, it can create external surpluses and lower domestic investment and consumption. All the elements described above are structural elements, and can be experienced by countries with an economic transition based on an “unbalanced” privatization.4

Under a progressive privatization of firms, the results show how important is the impact of credit market frictions, especially that of heterogeneous credit constraints. With high TFP growth, this public financial intermediation leads to an excessive aggregate saving rate hindering investment in the real economy and flowing abroad. It is exacerbated by financial liberalization. Although the high TFP growth in China attracts a large amount of FDI, capital expropriation and moral hazard slow it down. The latter also interacts with credit constraints by magnifying their effect. The impact of a low share of capital in production must not be neglected, because it makes private firms more labor intensive. One risk for this type of firms is a rise in wages due to looser credit constraints, which might decrease their returns. The international risk is a reduction of FDI-in which might maintain 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: all the frictions and losses in the real economy misallocate capital, slow-down investment, and decrease consumption.52

However, the model must be improved regarding some assumptions: a study with endogenous economic liberalization from SOE to private firms as in Song and al. (2011) would be more relevant, as endogenous corporate savings invested in foreign assets, and with non-zero financial outflows from developed countries. Regarding other extensions of the model and studies opportunities, we can mention the addition of FDI frictions with initial administrative costs, or the study under a risky framework with stochastic shocks.53

Of course the determinants of households and corporate savings must be studied deeper, as it is a main issue in China. An OLG model with pension system and social insurance could be interesting, as a new utility function reducing wealth effect. As for firms, an extension could be the introduction of dividend

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4 Regarding the decrease in consumption, as often mentioned in the paper, in the observed data the causes are different: low social protections and pensions largely increase households savings. As for the global imbalances phenomenon, the excessive indebtedness in developed countries also have 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.

52 Here the study focuses on structural issues and growth trends, with many deterministic shocks; so as not to be confused with the origin of the mechanisms driving the results, stochastic shocks are not included here. Obviously an extension with risk is necessary.
distributions or short and long-term projects. It would change savings and investments patterns. A study of welfare losses under these frictions would of course be interesting.
References

Technical report.


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7 appendix

7.1 Steady-state

Real interest rates

\[ r_d = \frac{1}{\beta(1 - \gamma_d)} - 1 \]
\[ r_f = \frac{1}{\beta(1 - \gamma_f)} - 1 \]

Capital demand yields

\[ \alpha_d \frac{Y_d}{K_d} (1 + g_{A_d}) = \frac{1}{\beta(1 - \gamma_d)} - 1 + \delta_d \]
\[ \alpha_d \frac{Y_d}{K_d^*} (1 + g_{A_f}) = \frac{1}{\beta(1 - \gamma_f)} - 1 + \delta_f \]
\[ \alpha_f \frac{Y_f}{K_f} (1 + g_{A_f}) = \frac{1}{\beta(1 - \gamma_f)} - 1 + \delta_f \]
\[ \alpha_f \frac{Y_f}{K_f^*} (1 + g_{A_d}) = \frac{1}{\beta(1 - \gamma_d)} - 1 + \delta_d \]

Capital

\[ K_d = \Upsilon_1 N_d = \left[ \frac{1}{\alpha_d(1 + g_{A_d})} - 1 + \delta_d \right]^{\frac{1}{\alpha_d - 1}} N_d \]
\[ K_d^* = \Upsilon_2 N_d^* = \left[ \frac{1}{\alpha_d(1 + g_{A_f})} - 1 + \delta_f \right]^{\frac{1}{\alpha_d - 1}} N_d^* \]
\[ K_f = \Upsilon_3 N_f = \left[ \frac{1}{\alpha_f(1 + g_{A_f})} - 1 + \delta_f \right]^{\frac{1}{\alpha_f - 1}} N_f \]
\[ K_f^* = \Upsilon_4 N_f^* = \left[ \frac{1}{\alpha_f(1 + g_{A_d})} - 1 + \delta_d \right]^{\frac{1}{\alpha_f - 1}} N_f^* \]

Investment

\[ I_d = \left[ \frac{g_{A_d} + \delta_d}{g_{A_d} + 1} \right] \left[ \frac{1}{\alpha_d(1 + g_{A_d})} - 1 + \delta_d \right]^{\frac{1}{\alpha_d - 1}} N_d \]
\[ I_d^* = \left[ \frac{g_{A_f} + \delta_f}{g_{A_f} + 1} \right] \left[ \frac{1}{\alpha_d(1 + g_{A_f})} - 1 + \delta_f \right]^{\frac{1}{\alpha_d - 1}} N_d^* \]
\[ I_f = \left[ \frac{g_{A_f} + \delta_f}{g_{A_f} + 1} \right] \left[ \frac{1}{\alpha_f(1 + g_{A_f})} - 1 + \delta_f \right]^{\frac{1}{\alpha_f - 1}} N_f \]
\[ I_f^* = \left[ \frac{g_{A_d} + \delta_d}{g_{A_d} + 1} \right] \left[ \frac{1}{\alpha_f(1 + g_{A_d})} - 1 + \delta_d \right]^{\frac{1}{\alpha_f - 1}} N_f^* \]
Production

\[ Y_d = Y_{1d} N_d = \left( \frac{1}{\beta(1 - \gamma_d)} - 1 + \delta_d \right)^\alpha_d \frac{\alpha_d}{\alpha_d(1 + g_{Ad})} N_d \]

\[ Y_{d^*} = Y_{2d^*} N_{d^*} = \left( \frac{1}{\beta(1 - \gamma_{df})} - 1 + \delta_{df} \right)^\alpha_d \frac{\alpha_d}{\alpha_d(1 + g_{Ad})} N_{d^*} \]

\[ Y_f = Y_{3f} N_f = \left( \frac{1}{\beta(1 - \gamma_f)} - 1 + \delta_f \right)^\alpha_f \frac{\alpha_f}{\alpha_f(1 + g_{Af})} N_f \]

\[ Y_{f^*} = Y_{4f^*} N_{f^*} = \left( \frac{1}{\beta(1 - \gamma_{df})} - 1 + \delta_{df} \right)^\alpha_f \frac{\alpha_f}{\alpha_f(1 + g_{Af})} N_{f^*} \]

Wages

\[ W_d = (1 - \alpha_d) \left[ \frac{1}{\beta(1 - \gamma_d)} - 1 + \delta_d \right] \frac{\alpha_d}{\alpha_d(1 + g_{Ad})} N_d \]

\[ W_{d^*} = (1 - \alpha_d) \left[ \frac{1}{\beta(1 - \gamma_{df})} - 1 + \delta_{df} \right] \frac{\alpha_d}{\alpha_d(1 + g_{Af})} N_{d^*} \]

\[ W_f = (1 - \alpha_f) \left[ \frac{1}{\beta(1 - \gamma_f)} - 1 + \delta_f \right] \frac{\alpha_f}{\alpha_f(1 + g_{Af})} N_f \]

\[ W_{f^*} = (1 - \alpha_f) \left[ \frac{1}{\beta(1 - \gamma_{df})} - 1 + \delta_{df} \right] \frac{\alpha_f}{\alpha_f(1 + g_{Af})} N_{f^*} \]

Consumption

\[ C_d = \Omega_1 N_d + \Omega_4 N_{f^*} \]

\[ C_f = \Omega_2 N_d + \Omega_3 N_f \]
with

\[
\begin{align*}
\Omega_1 & = \left[ \frac{1}{\beta(1-\gamma_d)} - 1 + \delta_d \right]^{\alpha_d^{-1}} \left[ \frac{g_A + \delta_d}{g_A + 1} \right]^{\alpha_d^{-1}} \left[ \frac{1}{\beta(1-\gamma_d)} - 1 + \delta_d \right]^{\alpha_d^{-1}} \\
\Omega_2 & = \left[ \frac{1}{\beta(1-\gamma_f)} - 1 + \delta_f \right]^{\alpha_f^{-1}} \left[ \frac{g_A + \delta_f}{g_A + 1} \right]^{\alpha_f^{-1}} \left[ \frac{1}{\beta(1-\gamma_f)} - 1 + \delta_f \right]^{\alpha_f^{-1}} \\
\Omega_3 & = \left[ \frac{1}{\beta(1-\gamma_f)} - 1 + \delta_f \right]^{\alpha_f^{-1}} \left[ \frac{g_A + \delta_f}{g_A + 1} \right]^{\alpha_f^{-1}} \left[ \frac{1}{\beta(1-\gamma_d)} - 1 + \delta_d \right]^{\alpha_d^{-1}} \\
\Omega_4 & = \left[ \frac{1}{\beta(1-\gamma_d)} - 1 + \delta_d \right]^{\alpha_d^{-1}} \left[ \frac{g_A + \delta_d}{g_A + 1} \right]^{\alpha_d^{-1}} \left[ \frac{1}{\beta(1-\gamma_f)} - 1 + \delta_f \right]^{\alpha_f^{-1}} \\
\end{align*}
\]

Labor supply

\[
\begin{align*}
N_d & = \Theta_1 N_f = \frac{(1-\alpha_d) \left[ \frac{1}{\beta(1-\gamma_d)} - 1 + \delta_d \right]^{\alpha_d^{-1}} \left[ \frac{g_A + \delta_d}{g_A + 1} \right]^{\alpha_d^{-1}}}{(1-\alpha_f) \left[ \frac{1}{\beta(1-\gamma_f)} - 1 + \delta_f \right]^{\alpha_f^{-1}} \left[ \frac{g_A + \delta_f}{g_A + 1} \right]^{\alpha_f^{-1}}} N_f, \\
N_f & = \Theta_2 N_d = \frac{(1-\alpha_f) \left[ \frac{1}{\beta(1-\gamma_f)} - 1 + \delta_f \right]^{\alpha_f^{-1}} \left[ \frac{g_A + \delta_f}{g_A + 1} \right]^{\alpha_f^{-1}}}{(1-\alpha_d) \left[ \frac{1}{\beta(1-\gamma_d)} - 1 + \delta_d \right]^{\alpha_d^{-1}} \left[ \frac{g_A + \delta_d}{g_A + 1} \right]^{\alpha_d^{-1}}} N_d, \\
N_{f*} & = \frac{1}{\phi} (1-\alpha_f) \left[ \frac{1}{\beta(1-\gamma_f)} - 1 + \delta_f \right]^{\alpha_f^{-1}} \left[ \frac{g_A + \delta_f}{g_A + 1} \right]^{\alpha_f^{-1}} \left[ \Omega_1 \Theta_1 + \Omega_4 \right]^{1/\sigma_f} \\
N_{d*} & = \frac{1}{\phi} (1-\alpha_d) \left[ \frac{1}{\beta(1-\gamma_d)} - 1 + \delta_d \right]^{\alpha_d^{-1}} \left[ \frac{g_A + \delta_d}{g_A + 1} \right]^{\alpha_d^{-1}} \left[ \Omega_2 \Theta_3 + \Omega_3 \Theta_2 \right]^{1/\sigma_d}
\end{align*}
\]
7.2 Dynamics

In the model solved along the balanced growth ($A_{d,t+1} = (1 + g_{A_d}).A_{d,t}$ and $A_{f,t+1} = (1 + g_{A_f}).A_{f,t}$) we get the following equations (for each variables $x_t = \frac{x}{X}$):

**Domestic firms:**

\[
\begin{align*}
y_{d,t} &= \frac{Y_{d,t}}{A_{d,t}} \\
y^*_{d,t} &= \frac{Y^*_{d,t}}{A_{f,t}} \\
k_{d,t} &= (1 - \delta_d) \frac{k_{d,t-1}}{1 + g_{A_d}} + i_{d,t} \\
k^*_{d,t} &= (1 - \delta_f) \frac{k^*_{d,t-1}}{1 + g_{A_f}} + i^*_{d,t} \\
b_{d,t} &= \frac{\epsilon_d}{1 + g_{A_d}} (k_{d,t-1} + k^*_{d,t-1}) \\
d_{d,T,t} &= b_{d,t} + b^*_{f,t} \\
dx_{d,t} &= \left( \frac{k_{d,t-1}}{k_{d,t-1} + k^*_{d,t-1}} \right).d_{d,T,t} \\
dx^*_{d,t} &= \left( \frac{k^*_{d,t-1}}{k_{d,t-1} + k^*_{d,t-1}} \right).d_{d,T,t}
\end{align*}
\]

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

\[
\begin{align*}
(1 - \alpha_d) \frac{yd_{d,t}}{Nd_{d,t}} &= w_{d,t} \\
(1 - \alpha_f) \frac{yd^*_{d,t}}{Nd^*_{d,t}} &= w^*_{d,t} \\
E_t \left[ \frac{\lambda_{d,t+1}}{\lambda_{d,t}} \left( 1 - \delta_d + \alpha_d \frac{yd_{d,t+1}}{k_{d,t}} (1 + g_{A_d}) - (1 + r_{d,t})(1 - \gamma_d) \right) \right] &= 0 \\
E_t \left[ \frac{\lambda_{d,t+1}}{\lambda_{d,t}} \left( 1 - \delta_f + \alpha_f \frac{yd^*_{d,t+1}}{k^*_{d,t}} (1 + g_{A_f}) - (1 + r_{d,t})(1 - \gamma_d) \right) \right] &= 0
\end{align*}
\]
Foreign firms:

\[
y_{f,t} = \frac{Y_{f,t}}{A_{f,t}} \]

\[
y^*_{f,t} = \frac{Y^*_{f,t}}{A_{d,t}} \]

\[
k_{f,t} = (1 - \delta_f) \frac{k_{f,t-1}}{1 + g_A_f} + i_{f,t} \]

\[
k^*_{f,t} = (1 - \delta_d) \frac{k^*_{f,t-1}}{1 + g_A_d} + i^*_{f,t} \]

\[
b_{f,t} = \frac{\zeta_f}{1 + g_A_f} (k_{f,t-1} + k^*_{f,t-1}) \]

\[
d_{f,t} = \frac{k_{f,t-1}}{k_{f,t-1} + k^*_{f,t-1}} d_{f,T,t} \]

\[
d^*_{f,t} = \frac{k^*_{f,t-1}}{k_{f,t-1} + k^*_{f,t-1}} d_{f,T,t} \]

Again, using Bellman equation and the value function

\[
V_{i,t} = u(c_{f,t}, N_{f,t}, N^*_{d,t}) + \beta_f E_t(V_{t+1}) - \lambda_{f,t}(\pi_{f,t}) \]

we get firms’ FOCs:

\[
(1 - \alpha_f) \frac{y_{f,t}}{N_{f,t}} = w_{f,t} \]

\[
(1 - \alpha_d) \frac{y^*_{f,t}}{N^*_{f,t}} = w^*_{f,t} \]

\[
E_t \left[ \frac{\lambda_{f,t+1}}{\lambda_{f,t}} \left( 1 - \delta_f + \alpha_f \frac{y_{f,t+1}}{k_{f,t}} (1 + g_A_f) - (1 + r_{f,t}) (1 - \gamma_f) \right) \right] = 0 \]

\[
E_t \left[ \frac{\lambda_{f,t+1}}{\lambda_{f,t}} \left( 1 - \delta_d + \alpha_d \frac{y^*_{f,t+1}}{k_{f,t}} (1 + g_A_d) - (1 + r_{f,t}) (1 - \gamma_f) \right) \right] = 0 \]
Domestic households:

\[
c_{d,t} + b_{d,t+1} + \varepsilon_t \left[ b^*_{d,t+1} \left( 1 + g_{A_d} \right) + \frac{\chi_d}{1 + \mu_d} \left( B^*_{d,t} - B^*_{d,t-1} \right)^{1+\mu_d} \right] = (1 + r_{f,t}) (1 - \gamma_f) \varepsilon_t b^*_{d,t} \\
+ (1 + r_{d,t}) (1 - \gamma_d) b_{d,t} + w_{d,t} N_{d,t} + w^*_{f,t} N^*_{f,t}
\]

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

\[
c_{d,t} = \lambda_{d,t} \\
\Phi N_{d,t} c_{d,t} = w_{d,t} \\
\Phi N^*_{f,t} c^*_{d,t} = w^*_{f,t} \\
\lambda_{d,t} \left[ (1 + g_{A_d}) + \chi_d \left( b^*_{d,t} - b^*_{d,t-1} \frac{1 + \mu_d}{1 + g_{A_d}} \right)^{\mu_d} \right] = \beta E_t (\lambda_{d,t+1} (1 + r_{d,t+1}) (1 - \gamma_d)) \\
\left[ (1 + g_{A_d}) + \chi_d \left( b^*_{d,t} - b^*_{d,t-1} \frac{1 + \mu_d}{1 + g_{A_d}} \right)^{\mu_d} \right] = \beta E_t (\lambda_{d,t+1} (1 + r_{f,t+1}) (1 - \gamma_f))
\]

Foreign households:

\[
c_{f,t} + b_{f,t+1} + \varepsilon_t \left[ b^*_{f,t+1} \left( 1 + g_{A_f} \right) + \frac{\chi_f}{1 + \mu_f} \left( B^*_{f,t} - B^*_{f,t-1} \right)^{1+\mu_f} \right] = (1 + r_{d,t}) (1 - \gamma_d) \varepsilon_t b^*_{f,t} \\
+ (1 + r_{f,t}) (1 - \gamma_f) b_{f,t} + w_{f,t} N_{f,t} + w^*_{d,t} N^*_{d,t}
\]

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

\[
c_{f,t} = \lambda_{f,t} \\
\Phi N^*_{f,t} c_{f,t} = w^*_{f,t} \\
\Phi N^*_{d,t} c^*_{f,t} = w^*_{d,t} \\
\lambda_{f,t} \left[ (1 + g_{A_f}) + \chi_f \left( b^*_{f,t} - b^*_{f,t-1} \frac{1 + \mu_f}{1 + g_{A_f}} \right)^{\mu_f} \right] = \beta E_t (\lambda_{f,t+1} (1 + r_{f,t+1}) (1 - \gamma_f)) \\
\left[ (1 + g_{A_f}) + \chi_f \left( b^*_{f,t} - b^*_{f,t-1} \frac{1 + \mu_f}{1 + g_{A_f}} \right)^{\mu_f} \right] = \beta E_t (\lambda_{f,t+1} (1 + r_{d,t+1}) (1 - \gamma_d))
\]
7.3 Other figures

Figure 15: Current accounts (% GDP)

Figure 16: Total profits over net value of fixed assets - Source: Song and al. (2011) (CSY, various issues)

DPE: domestic private enterprises
FE: foreign enterprises