

Two-Way Capital Flows and Global Imbalances: A Neoclassical Approach*

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(This version: November 2012)

Abstract

Financial capital and fixed capital tend to flow in opposite directions between poor and rich countries. Why? What are the implications of such two-way capital flows for global trade imbalances and welfare in the long run? This paper introduces frictions into a standard two-country neoclassical growth model to explain the pattern of two-way capital flows between emerging economies (such as China) and the developed world (such as the United States). We show how underdeveloped credit markets in China can lead to abnormally high rate of returns to fixed capital but excessively low rate of returns to financial capital relative to the U.S., hence driving out household savings (financial capital) on the one hand while simultaneously attracting foreign direct investment (FDI) on the other. When calibrated to match China's high marginal product of capital and low real interest rate, the model is able to account for the observed rising trends of China's financial capital outflows and FDI inflows as well as its massive trade imbalances. Despite double heterogeneity in households and firms and a less than 100% capital depreciation rate, our two-country model is analytically tractable with closed form solutions at the micro level, which permits exact aggregation by the law of large numbers, so the general equilibrium of the model can be solved by standard log-linearization or higher order perturbation methods without the need of using numerical computation methods. Our model yield, among other things, three implications that stand in sharp contrast with the existing literature: (i) Global trade imbalances between emerging economies and the developed world are sustainable even in the steady state. (ii) There exists an immiserization effect of FDI—namely, FDI is beneficial for the sourcing country but harmful to the recipient country under financial frictions. (iii) Our quantitative results cast doubts on the conventional wisdom that the "saving glut" of emerging economies is responsible for the low world interest rate.

*We thank Yili Chien, Kaiji Chen, Bill Gavin, Jiandong Ju, Qing Liu, B. Ravikumar, Tao Zha and seminar participants at Emory University, HKUST, Tsinghua University, Federal Reserve Bank of St. Louis and Columbia-Tsinghua Conference in International Economics for comments, and Judy Ahlers for editorial assistance. The usual disclaimer applies. *a*: Hong Kong University of Science & Technology. *b*: Federal Reserve Bank of St. Louis. *c*: Tsinghua University. Corresponding author: Zhiwei Xu, Department of Economics, Hong Kong University of Science and Technology, Clear Water Bay, Hong Kong. Email: zwxu@ust.hk. Tel.: (+852) 67334367.

Keywords: Allocation Puzzle, Saving Glut, Immiserization Effect of FDI, Global Imbalances, Two-Way Capital Flows, Welfare.

JEL Classification: E21, E22, E44, F21, F32, F34, F41.

1 Introduction

The pattern of international capital flows is a long-standing puzzle. Lucas (1990) pondered why capital does not flow from North (developed countries) to South (developing countries) despite that it is scarcer and commands a higher rate of return (or marginal product) in the South. The standard neoclassical growth theory attributes the high marginal product of capital (MPK) in the South to a low capital-to-labor ratio or low household saving, thus predicting savings to flow from rich to poor countries. But the truth is exactly the opposite—savings appear abundant in many emerging economies and they have been flowing massively into rich countries over the past decades.

To explain the "reversed capital flow" puzzle, the mainstream literature on global imbalances argues that the rate of return to capital is actually lower (rather than higher) in developing economies because of a savings glut (Bernanke, 2005). Hence, capital moves in the reversed direction—from South to North.

However, the reversed capital flow puzzle is partially a fallacy of aggregation. In reality, *fixed* capital does flow (and mainly) from North to South, in the form of foreign direct investment. It is *financial* capital (portfolio investment) that has been flowing in the opposite direction. Since historically the "uphill" flows of financial capital dominate the "downhill" flows of fixed capital, net aggregate capital flow (financial plus fixed) shows the reverse pattern.

For example, during the 1995-2003 period, industrial countries as a whole had net financial capital *inflows* (including foreign reserve decumulations) that averaged -\$266 billion and net FDI *outflows* that averaged \$115 billion per year. In contrast, the less developed countries (LDCs) as a block had net FDI *inflows* that averaged -\$154 billion per year and net financial capital *outflows* (including foreign reserve accumulations) that averaged \$171 billion. These opposite movements (or diverging trends) in financial and fixed capital flows have been growing over time.¹ In the meantime, industrial countries have been running large and persistent trade deficits with South. The major countries contributing to such global imbalances are the U.S. (representing developed countries) and China (representing LDCs in recent years). In particular, China is now both the largest holder of foreign reserves (\$3.2 trillion at the end of 2011, mostly U.S. government bonds) and the largest recipient of FDI (\$185 billion in 2010 with a total inflow of more than \$1 trillion in 1978-2009) among developing countries, as well as the major contributor to global current account imbalances (with a surplus of over \$400 billion in 2008). In contrast, the U.S. is the largest importer of financial capital from developing countries and the largest exporter of FDI to South. Meanwhile,

¹The statistics are based on data provided by Ott (2008).

the U.S. is also the country with the largest trade deficit (e.g., with a current account deficit of \$800 billion in 2008).

Persistent net capital inflows to a country would imply current account deficits in the short run but trade surplus in the long run because of positive interest payments in the steady state.² Since by textbook theory unidirectional one-way capital flow is not sustainable (i.e., a country's net foreign asset position should be zero at steady state), trade should always be balanced in the long run. However, if financial capital (e.g., bonds) and fixed capital (FDI) earn different rates of return and they flow in the opposite direction, a country can sustain long-run trade deficits (or a surplus) even if its net capital (financial and fixed) inflows are balanced at zero. For example, if the U.S. gleans a substantially larger rate of return from foreign capital than foreign investors do from owning U.S. capital (as in the data), it could run substantial trade deficits forever. Conversely, if China holds most of the world's low-yield foreign reserves and pays the highest rate of return to FDI inflows from rich countries, it will experience a trade surplus even in the long run.

Two-way capital flows have the opposite effect on the domestic interest rate. Therefore, it is not clear a priori that financial capital inflows from the South would necessarily reduce the interest rate in the North because FDI outflows will raise the MPK in the North. In addition, these two forms of capital flows reinforce each other through general equilibrium effects on the interest rate. For example, FDI inflows may crowd out domestic fixed capital investment in the recipient country and push down the real interest rate, which in turn can trigger financial capital outflows. This in turn may restore the interest rate to its original level. On the other hand, financial capital inflows reduce the real interest rate and the MPK in the recipient country, thus causing FDI outflows, which in turn raises the interest rate.

Despite the importance of FDI in North-South trade and its growing significance in rebalancing international capital flows and national current accounts, the bulk of the existing literature on global imbalances does not distinguish financial capital from fixed capital flows. Failing to distinguish these two forms of capital flows not only obscures our description of reality but may also impede correct theoretical analysis and empirical testing of different models aimed at explaining the global imbalances.

Why do fixed capital and financial capital move in opposite directions between the South and the North? Why do developing countries (such as China) lend massively to rich countries at low (or possibly negative) real interest rate while willing to pay dearly (in high returns) to attract foreign investment? In other words, why does the South lend cheaply and borrow expensively at the same

²A nation's current account balance (CA_t) is defined as the net changes in foreign asset positions (NFA_t):

$$CA_t = NFA_t - NFA_{t-1},$$

which is zero in the steady state. Since the current account equals net exports (NX_t) plus net factor payments ($r_t NFA_t$), where r denotes the interest rate, we have in the steady state $NX = -rNFA$. Thus, if the country has a negative foreign asset position because of capital inflows ($NFA < 0$), it runs a trade surplus in the steady state.

time? Are such seemingly irrational behaviors caused by distorted exchange rates and are they sustainable? Finally, what are the welfare implications of such two-way capital flows?

The standard neoclassical growth model and its open-economy analogue cannot answer these questions. These models assume that financial assets and fixed capital are either the same thing or have the same (or similar) rates of return under arbitrage. Hence, if capitals move across borders at all, they ought to flow in the same direction—consequently, the global imbalances are not sustainable. But such a synchronized (unidirectional) one-way capital flow is not what is observed in reality.

Intuitively, because capital flows are driven by rates of return, the observed two-way capital flows may suggest that the South has a higher rate of return to fixed capital but a lower rate of return (interest rate) to financial capital, so financial assets are relatively more attractive in the North while fixed investment is more profitable in the South. But what economic forces (frictions) might generate such a gap between the interest rate and the return to fixed capital that can explain the magnitudes of the imbalanced two-way capital flows? Why have arbitrage activities not closed the gap? In particular, why cannot Chinese firms lower their MPKs by borrowing cheaply at a low domestic interest rate?

This paper provides an explanation for the two-way capital flow puzzle by augmenting the neoclassical growth model with financial frictions. Specifically, following the approach of Gourinchas and Jeanne (2011), we augment the neoclassical growth model with two wedges: one wedge that distorts firms' investment decisions and one that distorts households' saving decisions. However, unlike Gourinchas and Jeanne's (2011) approach where the wedges are ad hoc black boxes, we derive these wedges explicitly through financial frictions, thus providing micro foundations for these theoretical constructs.

Our story proceeds as follows. Due to an underdeveloped banking-credit-financial system, both households and firms in the South are severely borrowing constrained. As a result, households opt to save excessively to self-insure against unpredictable shocks, and firms have to rely heavily on internal cash flows to finance fixed investment. Since domestic savings by households cannot be effectively channeled to firms where fixed capital formation takes place, fixed capital is scarce in the production sector while savings are abundant in the household sector. In such a world, the rate of return to financial assets can be significantly lower than that of fixed capital. In China, for example, the real rate of return to fixed capital has been over 20% in past decades while the real rate of return to financial capital (such as bank deposits and short-term bonds) has been negative (Bai, Hsieh, and Qian, 2006). Despite such an enormous gap, households in China save excessively and the bulk of their savings is in the form of bank deposits (Wen, 2010, 2011). This enormous arbitrage opportunity implies that financial liberalization between the South and the North will trigger two-way capital flows. Because it is relatively easier for financial capital to flow internationally than

shipping fixed capital abroad (e.g., transportation costs), the former will dominate the latter in global capital flows, resulting in short-run current account imbalances. In addition, because the rates of return to fixed and financial capital differ, the net income (interest) payments to the opposite capital flows do not cancel out, further contributing to global trade imbalances in the long run.

Therefore, in contrast to the standard neoclassical theory that attributes high MPK in the South to low household savings, we show how the lack of an efficient financial system in the South can lead to insufficient investment on the firm side but a saving glut on the household side, resulting in a high MPK and a low interest rate at the same time. This wedge in rates of return drives the observed two-way capital flows between developing and developed countries and the current account imbalances. More importantly, such two-way capital flows can sustain permanent trade imbalances even if the current account is perfectly balanced at zero.³

Our model can be calibrated to match (i) the observed gap between the financial interest rate and the rate of return to fixed capital in China and those in the developed countries, (ii) the high Chinese saving rate, and (iii) the massive and growing trends in two-way capital flows between China and its trading partners. The model also generates predictions that cast doubt on conventional wisdom in several fronts. First, Obstfeld and Rogoff (2000, 2007) have argued that a permanent trade imbalance is unsustainable, thus predicting that a reversal of the U.S. current account deficit is inevitable and that the future U.S. trade surplus requires substantial depreciation of the dollar's real exchange rate. Our model predicts instead that the U.S. is able to sustain a trade deficit of at least 3% of GDP permanently with China unless financial markets in China develop to the same degree as in the U.S.

Second, the popular view holds that the saving glut in emerging markets is responsible for the declining and sustained low interest rate in the U.S. (Bernanke, 2005). Our quantitative analysis shows that financial capital outflows from the South have a negligible impact on the interest rate in the North. At the peak of the impact after financial liberalization, the world interest rate in our model is reduced by less than 0.2 percentage points (or 20 basis points), and this effect dies out quickly in 2 years despite a persistent increase in capital flows (reaching over 30% of world GDP in terms of accumulated net foreign asset positions and 4% of world GDP in terms of trade imbalances, consistent with what is observed in the data).

Third, two-way capital flows have distinct welfare implications. The accepted wisdom (e.g., Caballero, Farhi, and Gourinchas, 2008; Mendoza, Quadrini, and Rois-Rull (MQR, 2009); Ju and Wei, 2010) is that developed countries gain unambiguously while developing countries lose after financial liberalization. We show instead that the opposite may be true: In general, capital exporting

³That is, imbalanced trade exists even if financial capital flows and fixed capital flows exactly cancel (balance) each other—because the cross-country net factor payments do not cancel each other due to the investment wedge.

countries gain unambiguously from financial liberalization while capital importing countries may gain or lose depending on the specific form of capital inflows. In addition, the welfare gains from the consumption margin and the leisure margin are quite different and often with the opposite sign.

Our analysis is related to a large and growing literature on global imbalances. Caballero et al. (2008) attribute the global imbalances to the inability of the South to generate saving instruments, thus causing the reversed capital flow after financial liberalization. MQR (2009) attribute the global imbalances to the heterogeneous degrees of financial development between developed and developing countries. Such heterogeneity implies that households in the North prefer riskier equity in their portfolios than do households in the South, inducing the South to maintain a positive net asset position in risk-free bonds. Similar to MQR (2009), Angeletos and Panousi (2011) attribute global imbalances to heterogeneous degree of idiosyncratic risks between the North and the South. Outflows of financial capital from the South is driven by its low interest rate under the precautionary saving motives. Similar to our paper, Angeletos and Panousi allow firms to accumulate fixed capital and their model can also generate a wedge between the MPK and the real interest rate. In contrast to our study, however, they do not study FDI and two-way capital flows. Related works also include Ohanian and Wright (2007), Sandri (2008), Carroll and Jeanne (2009), Durdu, Mendoza, and Terrones (2009), Buera and Shin (2010), Ju and Wei (2010), Chien and Naknoi (2011), Song, Storesletten, and Zilibotti (2011), Gourinchas and Jeanne (2011), and Wen (2011), among many others.⁴

However, the bulk of this literature does not distinguish between financial capital and fixed capital flows. As such, many of the models proposed to explain the global imbalances would be inconsistent with the empirical pattern of the two-way capital flows and trade imbalances. Typically, because no distinction is made between household savings and firms' fixed capital stocks, such a model would imply excess domestic savings in the form of tangible capital goods which are then rented to foreign firms as a means of capital outflows (e.g., Carroll and Jeanne, 2009). This particular form of capital outflows from the South to the North is inconsistent with the empirical facts.⁵ In addition, persistent capital flows from the South to the North would imply that the North runs a trade surplus (instead of deficits) with the South in the long run because of positive interest payments to the South. This prediction is not yet observed in the data.

To the best of our knowledge, little previous work has addressed the issue of two-way capital flows and their distinct welfare implications in a dynamic stochastic general equilibrium (DSGE) framework. The work closest to ours includes MQR (2009) and Chien and Naknoi (2011).⁶ Our

⁴This paper does not address the main issues raised by Wen (2011), especially the positive relationship between China's high saving rate and rapid income growth rate and the connection between capital controls and trade.

⁵Such a model that can generate low interest rates through precautionary savings would also imply low MPK (i.e., Aiyagari, 1994), but countries with saving gluts have high MPKs.

⁶Also see Hageny and Zhang (2011), Wen (2011), and Ju and Wei (2006, 2010). However, the model of Hageny

approach complements that of MQR in several aspects. In contrast to our full-fledged DSGE model, MQR assume that the stock of aggregate capital is fixed in each country and there is no labor market. Consequently, there are no cross-country fixed capital flows in their model by assumption.⁷ Most importantly, FDI in the model of MQR is modeled as purchasing foreign firms' equities. While foreign equity holding is a special form of FDI, it is no longer the major form of FDI in reality. Data show that the currently dominant form of FDI is setting up new firms or establishing new affiliations in foreign countries by exporting technology-embodied fixed capital and receiving factor payments as capital owners. For example, based on the total nonfinancial capital outflows from the U.S. to the rest of the world (ROW), the particular form of FDI assumed in the model of MQR (2009) accounts for less than 38% of total FDI, leaving more than 62% of U.S. FDI unexplained. In contrast, the specific form of FDI studied in our paper accounts for more than 76% of U.S. FDI outflows to China. Also, of China's total FDI inflows from developed countries, the new establishment of affiliations (or firms) with ownership fully belonging to foreigners accounts for 80% of China's total inward FDI in 2009 and 2010 and this number is still growing over time.⁸ Therefore, our approach represents a step forward toward understanding the mechanisms of FDI and its role in global imbalances.

Moreover, the model of MQR generates trade surplus for the U.S. in the longer term. In their model the interest payment on the inflow of financial capital from developing countries outweigh the returns from outward FDI, so the U.S. net foreign income payment is positive in the steady state. Hence, their model does not support the notion that the persistent U.S. trade deficits with China and the ROW may be sustainable in the long run.

In addition, the model of MQR is not analytically tractable. Because of computational burdens, MQR need to rule out any aggregate risks in their model. Without aggregate uncertainty, their model generates only a small risk premium for the rate of return to FDI (i.e., equity holdings of foreign capital stocks), and this small risk premium leads to a positive net factor payment (interest payment minus FDI earnings) in their model. To overcome the computational challenge under aggregate risk, Chien and Naknoi (2011) simplify the MQR model to a pure endowment economy and use a special algorithm to numerically solve the model. They show that with aggregate uncertainty (stochastic output growth), the model can generate a large risk premium between equity and risk-free bonds and thus is able to generate long-term trade deficits for the U.S. However, their model is not suited for studying the two-way capital flows discussed in this paper because it is an endowment economy without capital. In addition, they do not study the welfare consequences of

and Zhang (2011) is a deterministic 2-period model with a fundamentally different setup from ours; the model of Wen (2011) is a small open economy model with a focus on household savings; and the model of Ju and Wei (2010) is a static non-neoclassical model with a focus on corporate governance and property rights as the main frictions.

⁷However, they allow nonreproducible managerial capital or human capital to be reallocated across boards.

⁸See the Data Appendix (B.8) for details of the classifications and compositions of FDI in the U.S. and China.

financial liberalization.

In contrast, the wedge between the risk-free rate and the rate of return to FDI in our model does not hinge on the equity premium, but rather on Tobin's q because we allow firms to undertake fixed investment (Tobin's q is precisely the wedge between the MPK and the financial interest rate). As long as firms' borrowing constraints are tighter in developing countries, the South will have a higher MPK and experience a long-run trade surplus with the North regardless of aggregate uncertainty. In addition, since decision rules can be solved in closed form at the individual level, introducing aggregate risk into our model does not create computational burdens.⁹ Therefore, our model allows more transparent analysis of the welfare of financial liberalization as well as business cycle effects of financial shocks on the current account and trade balance.

The rest of the paper is organized as follows. Section 2 presents stylized facts about the two-way capital flows between China (representing the South) and the U.S. (representing the North). Sections 3 and 4 present our general equilibrium model. Section 5 studies the conditions for generating two-way capital flows. Section 6 provides quantitative predictions and welfare analyses. Section 7 concludes the paper.

2 Stylized Facts

We decompose global capital flows into financial capital flows and nonfinancial capital (FDI) flows. We use data from China to represent developing countries and those from the U.S. to represent the developed world.¹⁰ We begin with the following three observations.

- 1 *China is a net exporter of financial capital and a net importer of FDI, whereas the U.S. holds the opposite asset positions against developing countries (such as China).*

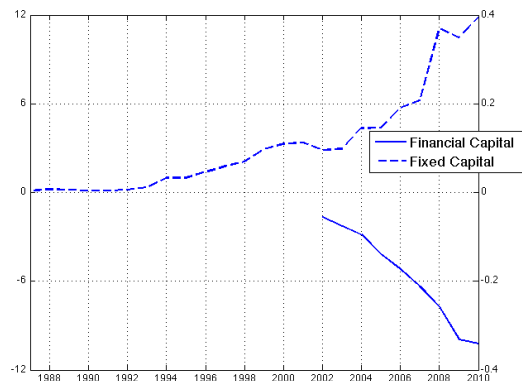


Fig. 1a. U.S.-China Foreign Asset Positions

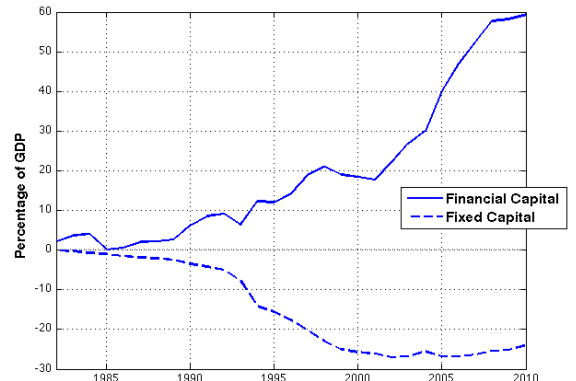


Fig 1b. China's Total Foreign Asset Positions

⁹ Aggregate uncertainty does not affect how individuals obtain closed-form solutions for their decision rules if aggregate shocks are orthogonal to idiosyncratic shocks.

¹⁰ Appendix B provides details about these data series.

Figure 1a shows the net foreign asset positions of the U.S. with respect to China. In particular, the upward trend line (dashed) shows the accumulated net FDI outflows from the U.S. to China as a share of U.S. GDP (right axis), and the negative downward trend line (solid) shows the accumulated net financial capital inflows from China to the U.S. as a share of U.S. GDP (left axis). Figure 1b plots the net foreign asset positions of China against the ROW. The positive and upward trend line (solid) is China's total accumulated net foreign asset positions for financial capital, which accounts for about 60% of China's GDP in 2010. The negative and downward trend line (dashed) shows China's total accumulated net FDI inflows, which account for about 30% of China's GDP in 2010.¹¹

2 *China has a significantly higher rate of return to fixed capital and a significantly lower rate of return to financial capital than the U.S.*

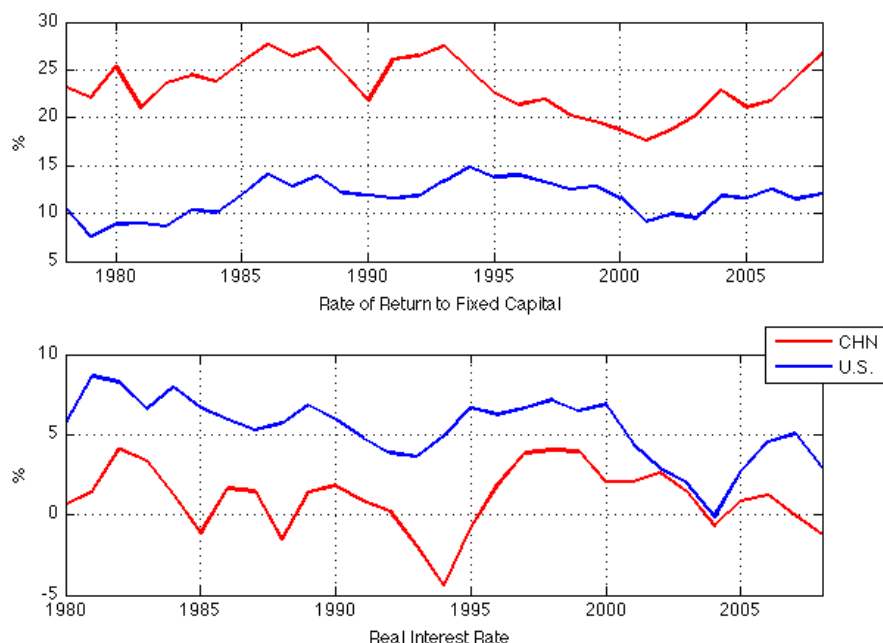


Figure 2. Rate of Return to Capital and Real Interest Rate in China and The U.S.

The top panel in Figure 2 compares the before-tax rates of return to fixed capital in China and the U.S. As shown, China's capital return (the red line) stays at a very high level over the entire sample period, with a mean of 23%. In contrast, the rate of return to fixed capital in the U.S. (the blue line) lies significantly below that of China for the entire sample period, with a mean about

¹¹ Because China has been growing much faster than the ROW, the FDI inflows to China appear to have slowed in recent years relative to China's GDP (Figure 1b). However, the U.S. FDI to China did not show such a pattern as a share of U.S. GDP (Figure 1a).

10%. The spread remains large over the entire sample period with only a slight decline beginning in the mid-1990s.¹²

Table 1. Real Interest Rates (Annual, 1990-2011)

Period	1 Month	3 Month	6 Month	1 Year	2 Year	3 Year	5 Year
China (Inflation Rate = 4.78%)							
Deposit rate (%)	−3.6	−1.79	−0.93	−0.13	0.44	1.01	1.62
Govt. bond (%)		−2.67	−2.58	−1.88		−1.77	−1.35
U.S. (Inflation Rate = 2.75%)							
CD (%)	1.07	1.15	1.26				
T-bill (%)		0.69	0.8	1.18			2.06

In contrast, the bottom panel in Figure 2 shows that there is also a systematic difference in the rates of return to financial capital between the two countries, but the spread is reversed. For example, the real interest rate (defined as the risk-adjusted annual lending rate) in the U.S. is about 6 percentage points (per unit of risk) on average, whereas that in China is about 1 percent on average. Table 1 also shows a systematic cross-country gap of about 3 percentage points in the real interest rate when bank deposit rates and government bond rates are compared.¹³

3 China has a less developed financial market than the U.S.

Figure 3 shows that private credit-to-GDP ratios in both China and the U.S. have been rising gradually over time, which may indicate financial improvement in both countries over time. However, the disparity between the two countries is large and does not show any tendency of diminishing over time. We obtain similar results when we use other measures of financial development, such as the financial development index in the World Competitiveness Report.¹⁴

Intuitively, the within- and cross-country disparities in asset returns to fixed and financial capital (observation 2) are the main driving force of international two-way capital flows (observation 1). But the question is this: What economic frictions might generate these disparities in asset returns within and across countries? In our two-country theoretical model, we make observation 3 a

¹²The after-tax rate of return in China is about 13% whereas that in the U.S. is about 7%. Therefore, even taking tax adjustments into account, the rates of return to fixed capital in the two countries are still significantly different from each other. We also calculate U.S. rate of return to fixed capital through Poterba (1998) method, the result changes little.

¹³The real rates in Table 1 are computed using CPI inflation rate in each country. U.S. data are from FRED (Federal Reserve Bank of St. Louis). Chinese data are from the People's Bank of China.

¹⁴We follow the existing literature (e.g., King and Levine, 1993) by using the total private credit-to-GDP ratio as a measure of financial development because this variable captures the ability of financial intermediaries to allocate credit. A persistently higher value in this ratio thus indicates a better financial system. The World Competitiveness Report (WCR) is released by the World Development Forum each year and contains several indices for financial development. Suppose we use Financial Market Sophistication index as an indicator for the financial development, China's index is significantly lower than the U.S. index. Moreover, the gap remains highly stable over the time.

key assumption to generate observation 2, and then explain observation 1 both qualitatively and quantitatively, among other things.

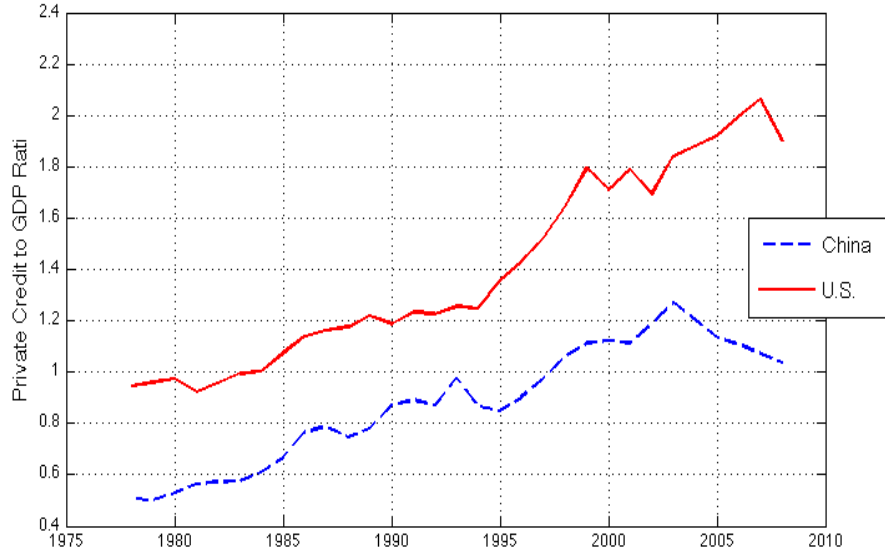


Figure 3. Financial Development in China and the U.S.

3 The Model

We consider an infinite-horizon economy with two countries, labeled h (home) and f (foreign), respectively. There is no aggregate uncertainty.¹⁵ Each country is composed of two types of heterogeneous agents: consumers and firms with equal mass normalized to 1. We use $i \in [0, 1]$ to index heterogeneous households and $j \in [0, 1]$ to index heterogeneous firms. Both households and firms are subject to idiosyncratic risks and borrowing constraints (specified below). Firms accumulate capital and combine labor and capital to produce consumption goods. Households supply labor to firms and can hold bonds and firms' stocks (or equities) as means of savings. There are two types of bonds, issued by countries h and f , respectively. Each country issues its own country-specific bonds, and no country can issue foreign bonds. To simplify the analysis we assume that bonds are the only tradable financial assets across countries.¹⁶ However, firms can invest in the foreign country through FDI. We use the tightness of borrowing constraints to indicate the degree of financial development in each country, as is standard in the literature (e.g., MQR, 2009).

¹⁵It is straightforward to introduce aggregate uncertainty in our model, which does not affect our results.

¹⁶Allowing households to hold foreign firms' equities does not change our results because bonds and equities are perfect substitutes for households. This simplifying assumption is made so we can focus on FDI in the form of shipping fixed capital across borders and not mangle it with acquiring the ownership of foreign firms through equity holdings.

Because firms are heterogeneous, each consumer holds a portfolio of firms' equities, taking as given the market prices of the portfolios.

We focus our analysis on the home country in what follows. The foreign country's problem is similar and analogous results can be obtained. Whenever convenient, we use $\ell = \{h, f\}$ as the country index and use ℓ_c to denote the counterpart of country ℓ .

3.1 Households

Households are subject to uninsurable idiosyncratic preference shocks (to the marginal utility of consumption). Such shocks capture the idiosyncratic uncertainty in consumption expenditures. Wen (2011) argues that such uncertainty in spending needs is extremely high in China because of the high probability of injuries, health hazards, and the stochastically rising costs of living. In each period t , household i derives utility from consumption c_{it} and leisure $1 - n_{it}$. The instantaneous utility function is quasi-linear, $\theta_{it} \log c_{it} - \psi n_{it}$, where the preference shock θ_{it} is drawn from a common distribution $F(\theta) = \Pr[\theta_i \leq \theta]$ with support $[\theta_{\min}, \theta_{\max}]$.

Each period is divided into two subperiods. The idiosyncratic preference shocks are realized in the second subperiod. Each household i chooses labor supply n_{it} in the first sub-period without observing θ_{it} . This implies that households cannot use the labor supply to insure themselves against the idiosyncratic shocks. Consumption and saving decisions are made in the second subperiod after preference shocks are realized. Specifically, after choosing n_{it} and upon observing θ_{it} , household i chooses consumption c_{it} , savings in domestic bonds s_{it+1} , savings in foreign bonds $\tilde{s}_{it+1}$, and savings in firms' equities a_{it+1} . As shown by Wen (2009, 2011), such an information and market structure permits closed-form solutions for household decision rules with incomplete markets and borrowing constraints.

Denoting Q_t as the price index of a portfolio of firms' equities (stocks) and D_t as the aggregate dividend paid to the portfolio (capturing the rate of return to stocks), the borrowing constraint facing each household is specified as

$$s_{it+1} + \tilde{s}_{it+1} + a_{it+1}Q_t \geq -B_t, \quad (1)$$

where a_{it+1} is the share of the portfolio newly purchased by the household in period t , and $B_t \geq 0$ is an exogenously specified borrowing limit (as in Aiyagari, 1994), which captures the degree of financial development on the household side at time t .

Since countries cannot issue foreign bonds (although households can hold foreign bonds), we have

$$\tilde{s}_{it+1} \geq 0 \quad (2)$$

for all $i \in [0, 1]$. This implies that if a country opts to borrow abroad, it must sell its home bonds to foreigners.¹⁷

Taking as given the real wage W_t and the real interest rates at home and abroad, household i solves

$$\max_{\{n_{it}, c_{it}, s_{it+1}, \tilde{s}_{it+1}, a_{it+1}\}} E_0 \left[\sum_{t=0}^{\infty} \beta^t (\theta_{it} \log c_{it} - \psi n_{it}) \right], \quad (3)$$

subject to constraints (1) and (2), as well as the budget constraint

$$c_{it} + s_{it+1} + \tilde{s}_{it+1} + a_{it+1} Q_t \leq R_{bt-1}^h s_{it} + R_{bt-1}^f \tilde{s}_{it} - \gamma_s \frac{\tilde{s}_{it}^{1+\tau}}{1+\tau} + W_t n_{it} + (Q_t + D_t) a_{it}, \quad (4)$$

where $\{R_{bt}^h, R_{bt}^f\}$ denote domestic and foreign interest rates, respectively, and $\gamma_s \frac{\tilde{s}_{it}^{1+\tau}}{1+\tau}$ denotes the convex cross-border trading costs for purchasing foreign bonds (with $\gamma_s \geq 0$ and $\tau > 0$).¹⁸

3.2 Firms

Each firm j with capital stock K_{jt} can choose to produce both at home and abroad. A firm combines labor and capital to produce output through Cobb-Douglas technology with capital share α and labor share $1 - \alpha$. Each firm accumulates productive capital according to the law of motion,

$$K_{jt+1} = (1 - \delta) K_{jt} + \varepsilon_{jt} I_{jt}, \quad (5)$$

where I_{jt} denotes investment expenditures and $\varepsilon_{jt} \in R^+$ is an idiosyncratic shock to the marginal efficiency of investment, which is i.i.d across firms and over time (as in Wang and Wen, 2011). We denote the probability density function of ε_{jt} by $\phi(\varepsilon)$ and the cumulative density function by $\Phi(\varepsilon)$.

With heterogeneous households, the firm's dynamic programming problem becomes slightly more complicated. The first step is finding the correct discount factor. We follow Hansen and Richard (1987), Cochrane (1991), and Wang, Xu and Xu (2011) to assume that there exists a sequence of prices $\{P_t\}_{t=0}^{\infty}$ such that a firm's expected value is determined by

$$V_{jt} = E_t \left[\sum_{\tau=0}^{\infty} \frac{P_{t+\tau}}{P_t} D_{jt+\tau} \right], \quad (6)$$

¹⁷The constraint in equation (2) is not essential. Our general results hold if we simply allow an international bond with a world interest rate. However, to capture the different interest rates in China and the U.S. both before and after financial liberalization, we need to have domestic and foreign bonds and asymmetric trading costs.

¹⁸We assume that there exist cross-border trading costs in purchasing foreign bonds and the costs are increasing in the trading volume. This assumption is not necessary for our general results but is needed only to capture the transitional dynamics of international financial capital flows after financial liberalization. China opens its capital markets only gradually; even today its capital markets are not completely open. So the rationale for such trading costs includes capital controls in developing countries in addition to other transaction costs discussed in the literature. However, our qualitative results do not hinge on the assumption of trading costs and our model nests the standard models with zero trading costs as a special case.

where $\{D_{jt+\tau}\}_{\tau=0}^{\infty}$ is the dividend flows generated by firm j and the expectation operator E is taken on the idiosyncratic shock ε_{jt} . Denote $\Lambda_t \equiv P_t/\rho^t$, where $\rho < 1$, we can rewrite the firm's expected value as $V_{jt} = E_t \left[\sum_{\tau=0}^{\infty} \rho^\tau \frac{\Lambda_{t+\tau}}{\Lambda_t} D_{jt+\tau} \right]$, which can be rewritten recursively as¹⁹

$$V_{jt} = \int \left(D_{jt} + \rho E_t \frac{\Lambda_{t+1}}{\Lambda_t} V_{jt+1} \right) d\Phi. \quad (7)$$

Notice that because of heterogeneity on the household side, ρ does not necessarily equal the household's discount factor β . With the firm value given by equation (7), the firm's problem is then to maximize its expected value V_{jt} by choosing labor demand, capital allocation (the share of FDI), and the level of fixed investment.

In the beginning of each period, firm j decides to allocate $1 - u_{jt}$ fraction of its fixed capital stock (K_{jt}) at home and the remaining u_{jt} fraction of the capital stock abroad.²⁰ We assume that there are costs involved in reallocating fixed capital across borders and a firm needs to pay the amount $\gamma_k \frac{u_{jt}^{1+\chi}}{1+\chi} K_{jt}$ to move u_{jt} fraction of its capital stock abroad. The parameters $\gamma_k (> 0)$ and $\chi (> 0)$ control capital mobility and the extent of openness for the fixed capital market. For example, when $\gamma_k = \infty$, cross-border fixed capital flows are completely shut down. When $\gamma_k = 0$, FDI flows can be adjusted instantaneously without any costs. This parameter also captures institutional costs for setting up foreign business and policies designed to attract FDI through reducing such frictions.²¹

The optimal choices of u_{jt} as well as labor inputs are static. Given the capital stock K_{jt} , firm j 's operating profits Π_{jt} can be derived through the following maximization problem:

$$\max_{\{u_{jt}, N_{jt}, X_{jt}\}} \left\{ ((1 - u_{jt})K_{jt})^\alpha N_{jt}^{1-\alpha} - W_t^h N_{jt} + (u_{jt}K_{jt})^\alpha X_{jt}^{1-\alpha} - W_t^f X_{jt} - \gamma_k \frac{u_{jt}^{1+\chi}}{1+\chi} K_{jt} \right\} \quad (8)$$

where W_t^h and W_t^f are the real wage in the home country and the foreign country, respectively, N_{jt} is the demand for domestic labor, and X_{jt} is the demand for foreign labor.

We now discuss the firm's dynamic optimization problem in choosing investment I_{jt} . Let $V_t(K_{jt})$ denote the expected value of the firm with capital stock K_{jt} at the beginning of period t before

¹⁹Notice that by our definition of firm's value, the value function V_{jt} is independent of the firm's idiosyncratic shock ε_{jt} in period t . This approach simplifies our notation but is not essential for our results. Alternatively, we could define a firm's value as $V_{jt} = D_{jt} + \rho E_t \frac{\Lambda_{t+1}}{\Lambda_t} V_{jt+1}$, so that it depends on period- t 's shock ε_{jt} .

²⁰The outward FDI of the home country in our model is thus $u_t K_t$. According to the BEA data source, this form of FDI dominates other forms of FDI flows.

²¹Even though financial and fixed capital move in opposite directions, net aggregate capital (financial plus fixed) still shows the reversed pattern noticed by Lucas (1990). The net foreign asset position of a country (the sum of net flows in financial and fixed capitals) is determined by the liquidity (mobility) of the two forms of capital. Thus the adjustment costs allow our model to quantitatively match the imbalanced two-way capital flows between China and the U.S.

observing ε_{jt} . This value function can now be defined recursively using the proper discount factor $\rho \frac{\Lambda_{t+1}}{\Lambda_t}$ as

$$V_t(K_{jt}) = \int \max_{I_{jt}} \left[\Pi_{jt} - I_{jt} + \rho E_t \frac{\Lambda_{t+1}}{\Lambda_t} V_{t+1}((1 - \delta) K_{jt} + \varepsilon_{jt} I_{jt}) \right] d\Phi. \quad (9)$$

We assume that a firm can use both internal funds, $\Pi_{jt}(K_{jt})$, and outside funds (from borrowing), L_{jt} , to finance investment. Hence, the maximum investment is subject to the constraint:

$$I_{jt} \leq L_{jt} + \Pi_{jt}. \quad (10)$$

For simplicity, we assume that the external funds are raised through intraperiod loans: Firms can borrow from financial intermediaries at the beginning of period t and pay back at the end of period t with zero interest rate. Since in each period some firms will opt not to invest ($I_{jt} = 0$), financial intermediaries can collect these inactive firms' savings and lend the funds to investing firms after paying dividends to equity holders (households).

Loans are subject to collateral constraints, as in Kiyotaki and Moore (1997). That is, firm j is allowed to pledge a fraction $\xi \in (0, 1]$ of its fixed capital stock K_{jt} at the beginning of period t as collateral. In general, the parameter ξ represents the extent of financial market imperfections—the higher the value of ξ , the more a firm can borrow and thus the more advanced the financial market. In the end of period t , the market value of the pledged collateral is equal to $\rho \frac{\Lambda_{t+1}}{\Lambda_t} V_{t+1}(\xi K_{jt})$, which is the present value of the collateral of firm j at the beginning of period $t + 1$, or equivalently the value of a firm that owns collateralizable capital stock ξK_{jt} . The amount of loans L_{jt} cannot exceed this collateral value because of limited contract enforcement. Thus, we impose the following collateral constraint:

$$L_{jt} \leq \rho \frac{\Lambda_{t+1}}{\Lambda_t} V_{t+1}(\xi K_{jt}). \quad (11)$$

We also assume that investment is irreversible,

$$I_{jt} \geq 0. \quad (12)$$

To summarise, each firm j solves the static problem (62) by choosing FDI u_{jt} and the dynamic programming problem (9) by choosing investment I_{jt} subject to constraints (10), (11), and (12).

3.3 Financial Intermediation

The financial intermediation in our model is stylized. A representative financial intermediary holds a portfolio consisting of all firms' stocks and collects the aggregate dividends D_t from all firms:

$$D_t = \int (R_{kt} K_{jt} - I_{jt}) dj. \quad (13)$$

Although the financial intermediary makes intraperiod loans to firms using the dividends, the loans are all repaid within the period, so they do not affect the end-of-period aggregate dividends. The price of such portfolio, Q_t , is hence

$$Q_t = \rho \frac{\Lambda_{t+1}}{\Lambda_t} [Q_{t+1} + D_{t+1}]. \quad (14)$$

Alternatively, one can also assume that households directly hold a market portfolio of equities that consists of stocks of all firms and the equilibrium results will be the same.

3.4 General Equilibrium

We denote the aggregate capital stock, aggregate investment, aggregate labor demand, aggregate output, aggregate labor supply, aggregate bonds holdings, aggregate household savings, and aggregate consumption in country ℓ by $K_t^\ell = \int_0^1 K_{jt}^\ell dj$, $I_t^\ell = \int_0^1 I_{jt}^\ell dj$, $N_t^\ell = \int_0^1 N_{jt}^\ell dj$, $X_t^\ell = \int_0^1 X_{jt}^\ell dj$, $Y_t^\ell = \int_0^1 Y_{jt}^\ell dj$, $n_t^\ell = \int_0^1 n_{it}^\ell di$, $S_t^\ell = \int s_{it}^\ell di$, $\tilde{S}_t^\ell = \int \tilde{s}_{it}^\ell di$, and $C_t^\ell = \int_0^1 c_{it}^\ell di$, respectively. The general equilibrium of the model is defined as the sequences of aggregate variables, $\{K_t^\ell, I_t^\ell, N_t^\ell, X_t^\ell, Y_t^\ell, n_t^\ell, S_t^\ell, \tilde{S}_t^\ell, C_t^\ell\}$, individual firms' decisions, $\{K_{jt}^\ell, I_{jt}^\ell, N_{jt}^\ell, L_{jt}^\ell, Y_{jt}^\ell\}$, individual households' choices, $\{a_{it}^\ell, n_{it}^\ell, s_{it}^\ell, \tilde{s}_{it}^\ell, c_{it}^\ell\}$, and aggregate prices, $\{Q_t^\ell, W_t^\ell, R_{kt}^\ell, R_{bt}^\ell\}$, for $\ell \in \{h, f\}$, such that each firm and each household solve their optimization problems and all markets (labor, equity, and bonds markets) clear:

$$N_t^\ell + X_t^{\ell c} \equiv \int_0^1 N_{jt}^\ell dj + \int_0^1 X_{jt}^{\ell c} dj = n_t^\ell \quad (15)$$

$$\int a_{it}^\ell di = 1. \quad (16)$$

Notice that in a financial autarky regime, the bond market-clearing conditions are

$$S_t^\ell = \tilde{S}_t^\ell = 0, \quad (17)$$

whereas in a financial liberalization regime, the bond market-clearing conditions are

$$S_t^\ell + \tilde{S}_t^{\ell c} = 0, \quad (18)$$

where $\tilde{S}_t^\ell$ denotes country ℓ 's holdings of the other country's (foreign) bonds. The aggregate capital stock evolves according to

$$K_{t+1}^\ell = (1 - \delta) K_t^\ell + \int \varepsilon_{jt}^\ell I_{jt}^\ell dj. \quad (19)$$

4 Solving the General Equilibrium

4.1 A Single Firm's Decision Rules

Let r_t denote the MPK and R_{kt} the marginal profit $\frac{\partial \Pi_{jt}}{\partial K_{jt}}$ (gross rate of return to fixed capital) of a firm. The following proposition shows that $\{r_t, R_{kt}\}$ are both independent of firms' idiosyncratic shocks and are closely related to each other. For convenience of analysis, we henceforth call R_{kt} (instead of r_t) the MPK unless confusion arises.

Proposition 1 *Given $\{r_t, r_t^f\}$, the optimal FDI decision (u_{jt}) is given by*

$$u_{jt} = \begin{cases} 0 & \text{if } r_t^f \leq r_t \\ \left(\frac{r_t^f - r_t}{\gamma_k} \right)^{\frac{1}{\chi}} & \text{if } r_t^f > r_t \end{cases}, \quad (20)$$

and the MPK (gross rate of return to fixed capital) is determined by

$$MPK \equiv R_{kt} = r_t + \mathbf{1}_{r_t^f > r_t} \left[\frac{\chi}{1 + \chi} \gamma_k^{-\frac{1}{\chi}} \left(r_t^f - r_t \right)^{\frac{1+\chi}{\chi}} \right], \quad (21)$$

where $\mathbf{1}_{r_t^f > r_t}$ is an index function that takes a value of 1 whenever $r_t^f > r_t$ and a value of 0 otherwise.

Proof. See Appendix A.1. ■

A firm's FDI decision depends completely on the spread of MPK between the two countries.²² It can be shown easily that the function MPK is strictly increasing in r_t and weakly increasing (non-decreasing) in r_t^f . Because of the constant returns to scale (CRS) production function and i.i.d. investment-efficiency shocks, both R_{kt} and r_t are independent of firms' idiosyncratic shocks. Based on this important property, we conjecture that the value of a firm is given by the following functional form suggested by Hayashi (1982):

$$V_t(K_{jt}) = v_t K_{jt}, \quad (22)$$

where v_t is the average (and marginal) value of a firm and depends only on the aggregate states. Hence, it is free of the firm index j . We define $q_t = \rho E_t \frac{\Lambda_{t+1}}{\Lambda_t} v_{t+1}$, which is the conventional measure of Tobin's q . With the conjectured value function, the firm's investment problem becomes

$$v_t K_{jt} = \int \max_{I_{jt}} \{R_{kt} K_{jt} - I_{jt} + q_t [(1 - \delta) K_{jt} + \varepsilon_{jt} I_{jt}]\} d\Phi, \quad (23)$$

²²We assume that the value of γ_k is large enough to ensure $u_{jt} < 1$.

subject to the constraints (10), (12), and

$$L_{jt} \leq q_t \xi K_{jt}. \quad (24)$$

Proposition 2 *There exists a cutoff $\bar{\varepsilon}_t = \frac{1}{q_t}$, such that the firm's optimal investment decisions follow a trigger strategy:*

$$I_{jt} = \begin{cases} q_t \xi K_{jt} + R_{kt} K_{jt} & \text{if } \varepsilon_{jt} > \bar{\varepsilon}_t \\ 0 & \text{otherwise} \end{cases}. \quad (25)$$

In addition, the marginal value of the firm is given by

$$v_t = R_{kt} + (1 - \delta) q_t + (q_t \xi + R_{kt}) \Omega(q_t), \quad (26)$$

where $\Omega(q_t) \equiv \int_{\varepsilon_{jt} > 1/q_t} (q_t \varepsilon_{jt} - 1) d\Phi$ with $\Omega'(q_t) > 0$, and Tobin's $q(q_t)$ evolves according to

$$q_t = \rho E_t \frac{\Lambda_{t+1}}{\Lambda_t} [R_{kt+1} + (1 - \delta) q_{t+1} + (q_{t+1} \xi + R_{kt+1}) \Omega(q_{t+1})]. \quad (27)$$

Proof. See Appendix A.2. ■

Briefly speaking, v_t is the value of one unit of existing capital and q_t is the value of one unit of newly installed capital. The marginal benefit of new investment is thus $q_t \varepsilon_{jt}$. Since the real cost of investment is 1, investment is profitable if and only if $q_t \varepsilon_{jt} > 1$ or $\varepsilon_{jt} > \bar{\varepsilon}_t \equiv 1/q_t$, which defines the cutoff. In such a case, the firm is willing to borrow as much as possible to invest, so its borrowing constraint binds. This explains the investment decision rule in equation (25).

By definition, q_t equals the discounted future value of one unit of capital in the next period $\rho E_t \frac{\Lambda_{t+1}}{\Lambda_t} v_{t+1}$, which is equation (27) after substitution using equation (26). The average (marginal) value of the firm (v_t) consists of three parts on the right-hand side of equation (26). First, one unit of capital can generate R_{kt} units of operating profit in period t . Second, one unit of capital can carry $1 - \delta$ remaining units to the next period with value $(1 - \delta) q_t$ after depreciation. Finally, the capital can also be used as collateral. With probability $1 - \Phi\left(\frac{1}{q_t}\right)$, the firm has a profitable investment opportunity and one unit of capital is able to obtain $q_t \xi$ units of loans, which can expand investment by $(q_t \xi + R_{kt})$ units by equation (25). After repaying the loans at zero interest rate, the net value of the loan is $(q_t \varepsilon_{jt} - 1)$; hence, the value of the collateral is $(q_t \xi + R_{kt}) \int_{\varepsilon_{jt} > 1/q_t} (q_t \varepsilon_{jt} - 1) d\Phi$. This explains equation (27).

4.2 A Single Household's Decision Rules

Proposition 3 *The optimal demand for foreign bonds $\tilde{s}_{it+1}$ is given by*

$$\tilde{s}_{it+1} = \begin{cases} 0 & \text{if } R_{bt} \geq R_{bt}^f \\ \left(\frac{R_{bt}^f - R_{bt}}{\gamma_s} \right)^{\frac{1}{\tau}} & \text{if } R_{bt} < R_{bt}^f \end{cases} . \quad (28)$$

Further, arbitrage among financial assets implies that the portfolio's price satisfies

$$Q_t = \frac{Q_{t+1} + D_{t+1}}{R_{bt}} . \quad (29)$$

Namely, the risk-free rate is the proper discounting factor for the firms.

Proof. See Appendix A.3. ■

The demand for foreign bonds is an increasing function of the cross-country interest spread, $R_{bt}^f - R_{bt}$, provided that the spread is positive. The parameter γ_s determines the cost of holding foreign bonds; it thus represents the extent of capital controls or transaction costs in the international bonds market. Financial autarky for bond trading is obtained if $\gamma_s = \infty$. In the limit as $\gamma_s \rightarrow 0$, the two interest rates, R_{bt}^f and R_{bt} , must be equalized in general equilibrium, so the model reduces to the standard setting with a single international bond.

Note that even for households with high realizations of preference shocks (or with a high urge to consume), they may still hold positive amount of foreign bonds $\tilde{s}_{it+1}$ provided that $R_{bt}^f > R_{bt}$, because they can borrow from the domestic bond market, i.e., $s_{it+1} < 0$. More importantly, equation (28) implies that the country with lower interest rate will have a positive net outflows in financial capital. Thus, to show the direction of financial capital flows, we only need to compare the interest rates in the two countries.

Denoting

$$H_{it} = (Q_t + D_t) a_{it} + W_t n_{it} + R_{bt-1} s_{it} + R_{bt-1}^f \tilde{s}_{it} - \gamma_s (\tilde{s}_{it})^{1+\tau} / (1 + \tau) \quad (30)$$

as the gross wealth of household i in period t , the following proposition shows that a household's consumption-saving decisions follow simple rules and that the distribution of gross wealth is degenerate across households (i.e., $H_{it} = H_t$ for all i).

Proposition 4 *Given the real wage W_t and the real interest rate R_{bt} , the optimal consumption and saving of household i are given, respectively, by*

$$c_{it} = \min \left\{ \frac{\theta_{it}}{\theta_t}, 1 \right\} (H_t + B_t) , \quad (31)$$

$$s_{it+1} + \tilde{s}_{it+1} + a_{it+1}Q_t = \max \left\{ \frac{\bar{\theta}_t - \theta_{it}}{\bar{\theta}_t}, 0 \right\} (H_t + B_t) - B_t, \quad (32)$$

where the target wealth H_t and the cutoff $\bar{\theta}_t$ are identical across i and jointly determined by the following two equations:

$$\bar{\theta}_t = \beta R_{bt} (H_t + B_t) E_t \left(\frac{\psi}{W_{t+1}} \right), \quad (33)$$

and

$$W_t \int \frac{\max(\theta, \bar{\theta}_t)}{H_t + B_t} d\Phi = \psi. \quad (34)$$

Proof. See Appendix A.4. ■

4.3 Wedges and System of Aggregate Dynamic Equations

Financial frictions introduce two wedges into our model compared with standard representative-agent neoclassical growth models. The saving wedge is introduced by borrowing constraints on the household side, and the investment wedge is introduced by borrowing constraints on the firm side. These wedges lead to low returns to household savings (financial interest rate) and high returns to firm investment (MPK), thus creating the driving forces of international two-way capital flows.

The CRS production technology implies that the equilibrium factor prices are $W_t^\ell = \frac{(1-\alpha)Y_t^\ell}{n_t^\ell}$ and $r_t^\ell = \frac{\alpha Y_t^\ell}{K_t^\ell}$, where the aggregate output $Y_t^\ell = (\bar{K}_t^\ell)^\alpha (n_t^\ell)^{1-\alpha}$ and the aggregate capital stock $\bar{K}_t^\ell = u_t^{\ell c} K_t^{\ell c} + (1 - u_t^\ell) K_t^\ell$. After aggregating households' decisions in equations (31) and (32) as well as the budget constraint,²³ and combining with equations (33) and (34), we obtain

$$\frac{\Psi(\bar{\theta}_t^\ell) \bar{\theta}_t^\ell}{C_t^\ell} = \beta R_{bt}^\ell \frac{\Psi(\bar{\theta}_{t+1}^\ell) \bar{\theta}_{t+1}^\ell}{C_{t+1}^\ell} G(\bar{\theta}_{t+1}^\ell), \quad (35)$$

$$\frac{\Psi(\bar{\theta}_t^\ell) \bar{\theta}_t^\ell}{C_t^\ell} W_t^\ell G(\bar{\theta}_t^\ell) = \psi^\ell, \quad (36)$$

where

$$G(\bar{\theta}_t^\ell) = \int \max\left(\frac{\theta}{\bar{\theta}_t^\ell}, 1\right) dF(\theta) > 1 \quad (37)$$

captures the liquidity premium of cash flows and $\Psi(\bar{\theta}_t^\ell) = \int \min\left(\frac{\theta}{\bar{\theta}_t^\ell}, 1\right) dF(\theta)$ captures the marginal propensity to consume. Equation (35) corresponds to the intertemporal Euler equations

²³The individual budget constraint is $c_{it} + s_{it+1} + \tilde{s}_{it+1} + a_{it+1}Q_t = H_{it}$, where H_{it} is defined in equation (30).

for consumption and saving and equation (36) to aggregate labor supply. If $\frac{\Psi(\bar{\theta}_t^{\ell})\bar{\theta}_t^{\ell}}{C_t^{\ell}}$ is treated as the aggregate marginal utility of consumption, then the savings wedge introduced by the financial friction on the household side is captured by the function $G(\bar{\theta})$. Because $G(\bar{\theta}) > 1$, the equation shows that the interest rate is lower than the rate of time preference ($\beta R_b < 1$), suggesting that financial friction induces higher saving (Aiyagari, 1994). The labor supply equation shows that financial friction induces a higher labor supply. The intuition is that the positive probability of a binding borrowing constraint induces the agent to work harder to provide enough liquidity to reduce that probability. This means that the effective rate of return to labor is the real wage compounded by the liquidity premium $G(\bar{\theta})$.

On the firm side, the Euler equation for capital investment is

$$q_t^{\ell} = \frac{1}{R_{bt}^{\ell}} \left[R_{kt+1}^{\ell} + (1 - \delta)q_{t+1}^{\ell} + (q_{t+1}^{\ell}\xi^{\ell} + R_{kt+1}^{\ell})\Omega(q_{t+1}^{\ell}) \right]. \quad (38)$$

Notice that if $\Omega(q_t^{\ell}) = 0$ and $q_t = 1$, the above equation is simply the standard neoclassical first-order condition with respect to capital investment. Therefore $\Omega(q_t^h) > 0$ together with $q_t > 1$ captures the investment wedge. It will be shown that Tobin's $q(q_t)$ measures the gap between the MPK and the financial interest rate.

Since the cutoffs $\{\bar{\theta}_t, 1/q_t\}$ provide sufficient statistics for the distribution of households and firms' allocations, the equilibrium dynamics of the model are characterized by a system of dynamic rational expectations equations in aggregate variables. Besides the above wedge equations representing financial frictions, the rest of the aggregate equations pertaining to the aggregate resource constraint, aggregate production function, aggregate capital accumulation, aggregate consumption, and aggregate investment are given, respectively, by

$$C_t^{\ell} + S_{t+1}^{\ell} + \tilde{S}_{t+1}^{\ell} + I_t^{\ell} + r_t^{\ell}u_t^{\ell c}K_t^{\ell c} + \frac{\gamma_s(\tilde{S}_{t-1}^{\ell})^{1+\tau}}{1+\tau} + \gamma_k\frac{(u_t^{\ell})^{1+\chi}}{1+\chi}K_t^h = Y_t^{\ell} + R_{bt-1}^{\ell}S_t^{\ell} + R_{bt-1}^{\ell c}\tilde{S}_t^{\ell} \quad (39)$$

$$Y_t^{\ell} = \left[u_t^{\ell c}K_t^{\ell c} + (1 - u_t^{\ell})K_t^{\ell} \right]^{\alpha} (n_t^{\ell})^{1-\alpha}. \quad (40)$$

$$K_{t+1}^{\ell} = \frac{\Gamma(q_t^{\ell})}{\pi(q_t^{\ell})}I_t^{\ell} + (1 - \delta)K_t^{\ell}, \quad (41)$$

$$C_t^{\ell} = \frac{\Psi(\bar{\theta}_t^{\ell})}{1 - \Psi(\bar{\theta}_t^{\ell})}(q_t^{\ell}K_{t+1}^{\ell} + S_{t+1}^{\ell} + \tilde{S}_{t+1}^{\ell} + B_t^{\ell}), \quad (42)$$

$$I_t^\ell = \pi(q_t^\ell) \left(R_{kt}^\ell + q_t^\ell \xi^\ell \right) K_t^\ell, \quad (43)$$

where $\pi(q_t^\ell) \equiv 1 - \Phi(1/q_t^\ell)$ and $\Gamma(q_t^\ell) \equiv \int_{\varepsilon > 1/q_t^\ell} \varepsilon d\Phi(\varepsilon)$. To facilitate analysis, we assume that the borrowing limit of the households is proportional to some aggregate variables, $B_t^\ell = b^\ell q_t^\ell K_t^\ell$, where the parameter $b^\ell \geq 0$ measures the tightness of borrowing constraints on the household side. A specific borrowing limit such as this permits balanced growth and facilitates steady-state calibrations. The total household income in equation (39) comes from several sources: total domestic output, returns from domestic bonds, and returns from foreign bonds. The aggregate consumption in equation (42) is proportional to total saving and borrowing limits (B_t). The aggregate investment is obtained through aggregating equation (25). For the financial autarky regime, we also add

$$S_{t+1}^\ell = \tilde{S}_{t+1}^\ell = u_t^\ell = 0. \quad (44)$$

For the financial liberalization regime, we also add

$$S_{t+1}^\ell + \tilde{S}_{t+1}^{\ell_c} = 0, \quad (45)$$

$$\tilde{S}_{t+1}^\ell = \mathbf{1}_{R_{bt}^{\ell_c} > R_{bt}^\ell} \left(\frac{R_{bt}^{\ell_c} - R_{bt}^\ell}{\gamma_s} \right)^{\frac{1}{\tau}}, \quad (46)$$

$$u_t^\ell = \mathbf{1}_{r_t^{\ell_c} > r_t^\ell} \left(\frac{r_t^{\ell_c} - r_t^\ell}{\gamma_k} \right)^{\frac{1}{\chi}}. \quad (47)$$

The system of equations (35)-(47) consists of 22 equations that determine the dynamic equilibrium path of 22 endogenous aggregate variables, $\{K_t^\ell, n_t^\ell, I_t^\ell, Y_t^\ell, q_t^\ell, C_t^\ell, \bar{\theta}_t^\ell, S_t^\ell, \tilde{S}_t^\ell, R_{bt}^\ell, u_t^\ell\}$, for $\ell = \{h, f\}$. The transitional equilibrium path from autarky to financial liberalization and impulse responses to aggregate shocks can all be computed straightforwardly by standard perturbation methods popular in the representative-agent model literature, such as the log-linearization method.²⁴ The local uniqueness of the equilibrium (saddle path) can be easily confirmed by checking the eigenvalues of the dynamic system near the steady state.

5 International Capital Flows

Everything else equal, the directions of international capital flows depend on the differential rates of return to financial and fixed capital across countries, which in turn depend on the demand and supply of capital and the degree of financial development in each country. This section characterizes

²⁴More specifically, we can compute the transition dynamics from autarky to financial liberalization according to the method in Juillard (1996). All calculations can be done with Dynare 4.0.

the relationships among the borrowing constraint parameters $\{b^\ell, \xi^\ell\}$, the interest rates $\{R_b^\ell\}$, and the MPKs $\{R_k^\ell\}$ for $\ell \in \{h, f\}$ through the lens of demand and supply of capital in each country and how they interact to determine the equilibrium interest rate and MPK.

In the model, both households and firms can save. Households save through bonds and equities (financial assets), whereas firms save through a domestic intraperiod loan market (i.e., a corporate union) with participation only by domestic firms. Firms will invest if and only if they receive good investment opportunities and will save (remain inactive) otherwise. Because it is costfree for firms to borrow from the corporate union (i.e., they pay zero interest for loans), only household savings depend directly on the interest rate in the financial market. In particular, the aggregate household savings depend positively on the interest rate.

Firms' investments are financed by two sources: internal cash flows and outside credit from the corporate union. Borrowing from the corporate union is free but subject to borrowing constraints. Hence, the aggregate demand for capital depends indirectly on the financial interest rate through the rate of return to equities. When the interest rate is high, the rate of return to equities must also be high to attract equity buyers. This means that either the equity price must be low or the dividend payment must be high. In either case, firms' present value of internal cash flows is reduced, which will decrease firms' investment demand. In addition to this intensive margin, the reduction of the equity price also raises the threshold (cutoff) of investing, thus lowering the aggregate investment through the extensive margin. Therefore, the aggregate demand for capital depends negatively on the interest rate, among other things.

Thus in the model household savings are channeled to firms through the equity market and they affect firms' investment demand through equity prices and dividends. When the household saving rate is high, the demand for equities will increase. In equilibrium, either the equity price level will increase or the average dividends will decrease; in either case, the rate of return to equities must decline. By arbitrage, the interest rate on bonds must also decline. This has positive effects on firms' investment demand because (i) a lower interest rate increases firms' present value of future cash flows due to a lower discount rate, and (ii) a lower dividend payment improves firms' cash positions. A higher investment rate by firms will then reduce the MPK. This suggests that financial capital inflows from other countries can lower domestic interest rate and the MPK of the home country. On the other hand, fixed capital inflows from foreign countries will (i) reduce the MPK in the home country and (ii) lower the domestic interest rate because it reduces the equity return at home.

For the U.S., the inflows of financial capital will decrease the domestic interest rate and the MPK, but meanwhile the outflows of FDI will increase its interest rate and the MPK. Therefore, two-way capital flows have the opposite effects on domestic interest rate and the MPK. This suggests

that financial liberalization may not necessarily decrease the U.S. interest rate unless financial capital inflows dominate FDI outflows. On the other hand, the effects of financial development on the interest rate and the MPK are somewhat different from those of capital flows and are more complicated because changes in the borrowing constraints (e.g., ξ) have ambiguous effects on the interest rate (since they simultaneously shift the demand and supply curves of capital). These effects are studied below.

5.1 Aggregate Capital Demand

We first derive the steady-state demand function for aggregate capital in the home country based on firms' investment behaviors. From the evolution equations of Tobin's q (38) and capital stock (41) as well as the aggregate investment (43), we obtain the following two equations that implicitly describe the gross rate of return to fixed capital R_k (MPK) and Tobin's q as functions of the real interest rate R_b

$$\delta = (R_k + q\xi) \Gamma(q), \quad (48)$$

$$R_k = q(R_b - 1) + \delta \frac{1}{\Gamma(q)/\pi(q)}. \quad (49)$$

where $\pi(q) = 1 - \Phi(1/q)$, and $\Gamma(q) = \int_{\varepsilon > 1/q} \varepsilon d\Phi$. The term $\Gamma(q)/\pi(q)$ on the RHS of the last equation is the average investment efficiency for active firms; thus, it is increasing in the cutoff $1/q$ or decreasing in q . This equation suggests that the Tobin's q (q) measures the spread between the return of fixed capital and the return of financial capital (the interest rate). Indeed, if we assume that the efficiency shock ε_j follows binomial distribution with only two realizations, 0 and 1, then the above equation reduces to $R_k - \delta = q(R_b - 1)$. In this case, q is exactly the wedge between the return of fixed capital (MPK) and the real interest rate at home.

Combining equations (48) and (49), we can solve R_k and q as function of the interest rate R_b and the financial development parameter ξ : $R_k \equiv \mathbb{R}(R_b, \xi)$, $q \equiv \mathbb{Q}(R_b, \xi)$. The following proposition shows that given the interest rate, the country with lower financial development (ξ) on the firm side tends to have both a higher Tobin's q and a higher MPK.

Proposition 5 *The function of MPK $\mathbb{R}$ is strictly increasing in the interest rate R_b and strictly decreasing in the financial development ξ , that is, $\frac{\partial \mathbb{R}(R_b, \xi)}{\partial R_b} > 0$ and $\frac{\partial \mathbb{R}(R_b, \xi)}{\partial \xi} < 0$. The function of Tobin's q ($\mathbb{Q}$) is strictly decreasing in both the interest rate R_b and the financial development ξ , that is, $\frac{\partial \mathbb{Q}(R_b, \xi)}{\partial R_b} < 0$ and $\frac{\partial \mathbb{Q}(R_b, \xi)}{\partial \xi} < 0$.*

Proof. By the fact that both $\Gamma(q)$ and $\frac{1}{\Gamma(q)/\pi(q)}$ are strictly increasing in q , the results can be obtained easily through the implicit function theorem. ■

Our model predicts that the MPK and financial interest rate are positively correlated but the correlation is not perfect—there is a wedge between the two and the magnitude of this wedge (Tobin's q) depends crucially on the degree of financial development. The wedge is smaller and the correlation is stronger for countries that are financially more developed. These predictions are consistent with the empirical findings of Ohanian and Wright (2007).

To obtain the aggregate capital demand function, we need to link the MPK to the capital-to-output ratio. According to the discussions in Section 4.2, the LHS of equation (49) is increasing in r_t and thus decreasing in capital-to-output ratio $\frac{\bar{K}}{\bar{Y}}$. On the other hand, Proposition 5 implies that the RHS of equation (49) is increasing in the interest rate R_b . Therefore, equation (49) implicitly describes the aggregate capital demand (or the capital-to-output ratio) as a downward sloping function of the interest rate.

5.2 Aggregate Capital Supply

We now derive the aggregate capital supply from the household side. From equation (36), the cut-off $\bar{\theta}$ is implicitly determined by

$$\beta R_b G(\bar{\theta}) = 1. \quad (50)$$

Since G is a decreasing function of $\bar{\theta}$, equation (50) implies the cutoff is increasing in R_b . Since $G > 1$, the financial frictions on the household side make the steady-state interest rate R_b lower than $1/\beta$. The presence of borrowing constraints limits households' ability to diversify the uninsurable risk θ , thus inducing households to over-save to self-insure against risks. The oversaving behavior consequently reduces the interest rate in equilibrium.

Now, combining equations (39), (42) and (49), and with some algebra, we have

$$\begin{aligned} (1 - \alpha) \left[(1 - u) + \kappa u^f \right] \frac{Y}{\bar{K}} &= \left(\frac{1}{1 - \Psi} - R_b \right) q + \frac{\Psi}{1 - \Psi} qb \\ &+ \left(\frac{1}{1 - \Psi} - R_b \right) \frac{S}{K} + \left[\frac{1}{1 - \Psi} - \left(\frac{\tau}{1 + \tau} R_b^f + \frac{1}{1 + \tau} R_b \right) \right] \frac{\tilde{S}}{\bar{K}}, \end{aligned} \quad (51)$$

where $\bar{K} = u^f K^f + (1 - u) K$ is total world capital stock employed by the home country and $\kappa \equiv \frac{K^f}{K}$ is the relative ratio of fixed capital stocks in the two countries.

Equation (51) describes the aggregate supply of capital (capital-to-output ratio) for the home country as a positive function of the interest rate. Given u^f and κ , the LHS of the equation is

decreasing in $\frac{\bar{K}}{\bar{Y}}$ since both $1 - u$ and $\frac{Y}{K}$ are decreasing in $\frac{\bar{K}}{\bar{Y}}$; whereas given R_b^f (and ignoring the terms S and $\tilde{S}$ for simplicity), the RHS of (51) is decreasing in R_b since both Ψ and q are decreasing functions of R_b .²⁵

5.3 General Equilibrium in the Capital Market

To close the 2-country model, we need a market clearing condition for international bonds to determine the foreign reserves $\tilde{S}^h$ at home and $\tilde{S}^f$ abroad. From equations (18), we have

$$\tilde{S}^h = -S^f \text{ and } S^h = -\tilde{S}^f. \quad (52)$$

The general equilibrium of the 2-country model with financial integration can be characterized by the equilibrium capital-to-output ratios $\left\{ \frac{\bar{K}^h}{\bar{Y}^h}, \frac{\bar{K}^f}{\bar{Y}^f} \right\}$ and the real interest rates $\left\{ R_b^h, R_b^f \right\}$, which are determined jointly by the demand and supply of capital in the two countries.

However, to understand the factors determining the rates of return to capital and the directions of capital flows, it helps to study a world without international capital flows—the financial autarky regime. A financial autarky is defined as the economy without international capital flows, regardless of financial or fixed capital. To obtain a financial autarky regime, we can simply set the cost parameters γ_k and γ_s to infinity so there are no cross-border flows in financial and fixed capitals (i.e., $u^\ell = S^\ell = \tilde{S}^\ell = 0$). In a financial autarky equilibrium, the demand function (49) and supply function (51) of capital in the two countries collapse to

$$\alpha \frac{Y^\ell}{K^\ell} = \mathbb{R} \left(R_b^\ell, \xi^\ell \right), \quad (53)$$

$$(1 - \alpha) \frac{Y^\ell}{K^\ell} = \left(\frac{\Psi^\ell}{1 - \Psi^\ell} - R_b^\ell + 1 \right) q^\ell + \frac{\Psi^\ell}{1 - \Psi^\ell} q^\ell b^\ell, \quad (54)$$

for $\ell = \{h, f\}$. Note that due to the immobility of both fixed and financial capital, there is no interaction between the two countries, and the equilibrium capital-to-output ratio and interest rate in each country are then fully pinned down by the domestic capital demand curve and capital supply curve in equations (53) and (54).

Proposition 6 *In the financial autarky regime, the country with tighter borrowing constraints on the firm side (i.e., smaller ξ) has a higher MPK but either a higher or a lower domestic interest*

²⁵Here we implicitly assume the term $\frac{1}{1-\Psi} - R_b$ is strictly positive. Indeed, this assumption holds under fairly weak conditions. To see this, since $\frac{1}{1-\Psi} - R_b > 0$ implies $1 - \Psi < 1/R_b$, from equation (50), we only need to show $1 - \Psi < \beta G$. According to the definitions of Ψ and G , the last inequality is equivalent to $(1 - \beta) F(\bar{\theta}) < \int_{\theta < \bar{\theta}} \frac{\theta}{\bar{\theta}} dF + \beta \int_{\theta > \bar{\theta}} \frac{\theta}{\bar{\theta}} dF$. Therefore, we only need to show $F(\bar{\theta}) < \frac{\beta}{1-\beta} \left(\int_{\theta < \bar{\theta}} \frac{\theta}{\bar{\theta}} dF + \int_{\theta > \bar{\theta}} \frac{\theta}{\bar{\theta}} dF \right)$. This inequality always holds if we have $\frac{E(\theta)}{\bar{\theta}} \geq \frac{1-\beta}{\beta}$, which is easily satisfied under the conditions that $\beta \rightarrow 1$ and b is not too large (to ensure $\bar{\theta} \ll \theta_{\max}$).

rate; and the country with tighter borrowing constraints on the household side (i.e., smaller b) has both a lower MPK and a lower real interest rate.

The proof is straightforward and can be illustrated graphically. The left panel in Figure 4 is the autarky equilibrium in which the two countries differ only in the degree of borrowing constraints on the firm side, but they have the same degree of borrowing constraints on the household side. Specifically, suppose firms in country f can borrow more than firms in country h : $\xi^f > \xi^h$. The "S-S" curve in Figure 4 represents capital supply and the "D-D" curve capital demand, and point H represents autarky equilibrium in country h and point F autarky equilibrium in country f . According to equations (53) and (54), a larger ξ will shift both the demand and the supply curves towards the right. As a result, point H lies on the left side of point F and the home country has a lower capital-to-output ratio (or a higher MPK). The rank of interest rates in the two countries, however, is ambiguous since point F can be either above or below point H , depending on the magnitudes of the right-ward shifts of the two curves. The intuition is that looser borrowing constraints on firms in the foreign country lead to a higher demand for capital, which shifts out the "D-D" demand curve directly and results in a lower Tobin's q due to the lowered MPK. A lower Tobin's q in turn leads to a lower equity price (Q). Thus, households are willing to buy more equities or, equivalently, save more. As a result, the "S-S" supply curve will also shift out to the right. Consequently, whether the equilibrium interest rate is lower or higher than that in country h is ambiguous.

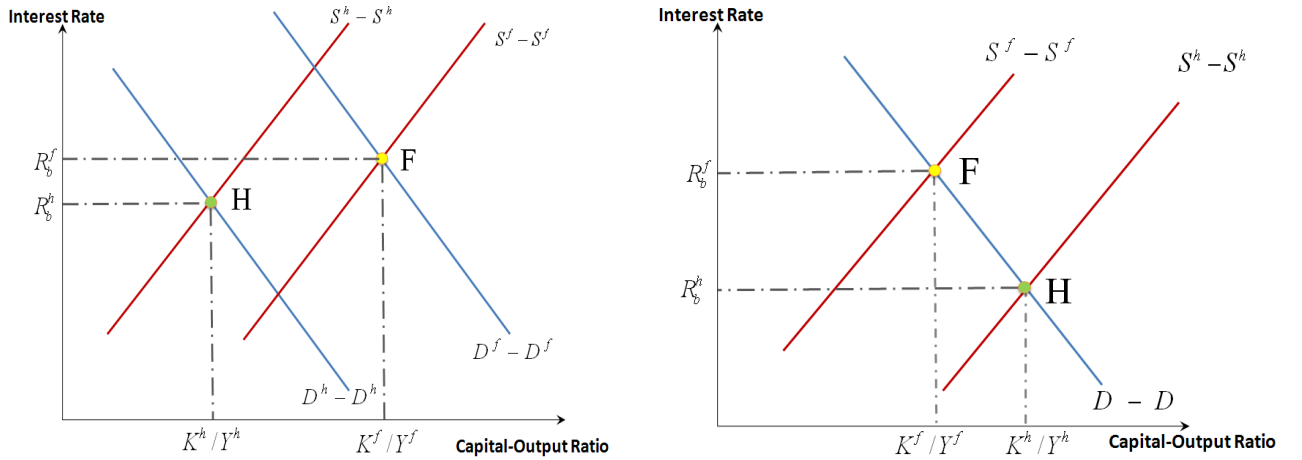


Figure 4. The Steady-State Equilibrium in the Financial Autarky

The right panel in Figure 4 illustrates the case in which the degree of borrowing constraints is identical on the firm side between the two countries while that on the household side is different. Assume households in country f are less borrowing constrained, $b^f < b^h$. From equation (53),

capital demand in the two countries is thus identical since $\xi^h = \xi^f$, but the capital supply curve in the foreign country lies on the LHS of the home country's. This occurs because households in the foreign country tend to borrow more and save less due to a less constrained borrowing limit. In equilibrium, the foreign country (labeled by point F) ends up with both a higher interest rate and a higher MPK (lower capital-to-output ratio) than the home country (point H).

This result shows that LDCs could have both a lower interest rate and a lower MPK than developed countries. Consequently, both financial capital and fixed capital should flow from the South to the North. Although such a one-way unidirectional capital flow is observed in the real world for some developing countries (such as the oil-exporting countries in the Middle East), it is not the dominant pattern of international capital flows. The above discussions indicate that explaining the two-way capital flow puzzle requires borrowing constraints on both the household side and the firm side.

5.4 Two-Way Capital Flows

Proposition 7 *Moving from financial autarky to financial liberalization (i.e., $\gamma_k < \infty$ and $\gamma_s < \infty$), financial capital will flow from country h to country f and fixed capital (FDI) will flow in the opposite direction simultaneously if one of the following sets of conditions are satisfied: (i) $\xi^h < \xi^f$ and $\underline{b}(\xi^f, \xi^h, b^f) < b^h < \bar{b}(\xi^f, \xi^h, b^f)$, or (ii) $b^h < b^f$ and $\xi^h < \underline{\xi}(\xi^f, b^h, b^f)$, provided that ε_{jt} is Pareto distributed.*

Proof. See Appendix A.5. ■

As shown in the previous discussions (see Figure 4), the assumption of $\xi^h < \xi^f$ alone guarantees that the home country has a higher MPK in autarky and thus country h would attract FDI from abroad. However, the direction of financial capital flow is ambiguous in this case because the autarky interest rate at home can be either lower or higher than the foreign interest rate. Therefore, to ensure a lower interest rate at home, we also need the household side to face a tight enough borrowing constraint ($b^h < \bar{b}$). However, since a tighter borrowing constraint on the household side also lowers the MPK at home, the value of b^h cannot be too low (i.e., $b^h > \underline{b}$). This explains the first set of conditions in the proposition.

On the other hand, the assumption of $b^h < b^f$ alone ensures that the home country has both a lower interest rate and a lower MPK, so we also need a tight enough borrowing constraint on the firm side at home (or a loose enough borrowing constraint abroad) to induce a higher MPK at home than abroad. However, although a lower ξ^h at home induces a higher MPK, its effect on the interest rate R_b^h is ambiguous. Therefore, we do not know if the home country will necessarily have a lower interest rate if ξ^h is reduced. One special case is that if ε follows the Pareto distribution,

then the interest rate depends only on b^ℓ , so the value of ξ^ℓ does not affect the interest rate. This explains the second set of conditions in the proposition.

Since capital flow itself can change the equilibrium interest rate and MPK, it is worth emphasizing that in our model FDI and financial capital flows tend to reinforce each other in the opposite direction by their general-equilibrium effects on the interest rate and MPK. Specifically, FDI inflows from f to h tend to drive out h 's financial capital because inward FDI lowers the domestic interest rate; and bonds inflows from h to f tend to drive out fixed capital in f toward h because inward financial capital flows brings down f 's MPK. Therefore, the parameter requirements on the values of $\{\xi^\ell, b^\ell\}$ for triggering two-way capital flows are much easier to satisfy than appear in Proposition 7.

5.5 Balance of Payments

The balance of payments is straightforward to compute in our model. For bonds flows we have $S_t^h = -\tilde{S}_t^f$ and $\tilde{S}_t^h = -S_t^h$. Moreover, either $S_t^h > 0$ or $\tilde{S}_t^h > 0$, but not both. For fixed capital flows, only one of the following conditions is true: either $u_t^h > 0$ or $u_t^f > 0$, but not both. Suppose $\tilde{S}_t^h > 0$ and $u_t^f > 0$ (as in the data). The current account balance of the home country (CA_t^h) in period t is then given by

$$CA_t^h = \left[\tilde{S}_{t+1}^h - \tilde{S}_t^h \right] - \left[u_t^f K_t^f - u_{t-1}^f K_{t-1}^f \right], \quad (55)$$

where the terms inside the first bracket on the RHS are the changes of financial asset positions and those in the second bracket are the changes of nonfinancial asset (FDI) positions. The net factor payments (NFP_t^h) from abroad to the home country are given by

$$NFP_t^h = \left[R_{bt-1}^f \tilde{S}_t^h - \tilde{S}_t^h \right] - r_t^h u_t^f K_t^f, \quad (56)$$

where terms inside the square bracket on the RHS are the interest rate payments from abroad and the second term on the RHS is the home country's net income payments (rents) to foreign firms' FDI. The trade balance of the home country (TB_t^h) can be obtained from the following accounting identity²⁶:

$$TB_t^h = CA_t^h - NFP_t^h. \quad (57)$$

²⁶To be precise, aggregating the individual budget constraint in the home country gives

$$\left(\tilde{S}_{t+1}^h - \tilde{S}_t^h \right) - \left(u_t^f K_t^f - u_{t-1}^f K_{t-1}^f \right) = Y_t^h - \left(C_t^h + \hat{I}_t^h \right) + \left(R_{bt-1}^f \tilde{S}_t^h - \tilde{S}_t^h \right) - r_t^h u_t^f K_t^f$$

where $\hat{I}_t^h$ is the total domestic investment including investments from both domestic firms and foreign firms and the cross-border adjustment costs. The trade balance is thus $Y_t^h - \left(C_t^h + \hat{I}_t^h \right) = CA_t^h - NFP_t^h$.

Substituting equations (55) and (56) into equation (57) gives the relationship between trade balance and capital account balance (KA_t):

$$TB_t^h = \underbrace{\left[\left(1 + \hat{r}_t^h\right) u_{t-1}^f K_{t-1}^f - R_{bt-1}^f \tilde{S}_t^h \right]}_{\text{Gross Interest Payments}} - \underbrace{\left(u_t^f K_t^f - \tilde{S}_{t+1}^h \right)}_{KA_t^h}. \quad (58)$$

where $\hat{r}_t^h = r_t^h (1 + g_{FDI,t})$ and $g_{FDI,t}$ is the growth rate of the FDI position. Equation (58) implies that capital-account surplus ($KA_t^h > 0$) may not necessarily imply trade deficit ($TB_t^h < 0$) because it also depends on the magnitude of the gross interest payments on financial and fixed capital flows. For instance, if the gross interest payments are positive because of a higher rate of return to FDI than the interest on foreign reserves, then it is possible that the home country experiences a trade surplus in the steady state despite that it has zero (or positive) balances on its capital account ($KA_t^h \geq 0$). This suggests that China's trade surplus with the U.S. may be sustainable in the long run even if net capital (financial plus fixed capital) flows between the two countries are balanced at zero ($KA_t^h = 0$).

6 Quantitative Analysis

6.1 Calibration

We now calibrate the deep parameters in the model by taking country h as China and country f as the rest of the world (ROW). Let the time period be one quarter, the discounting factor $\beta = 0.99$, the capital share $\alpha = 0.4$, and the leisure coefficient in the utility function $\psi = 2.5$.²⁷ Both the idiosyncratic investment shock ε and the idiosyncratic preference shock θ follow Pareto distributions, with distribution $1 - \left(\frac{\varepsilon}{\varepsilon_{\min}}\right)^{-\sigma}$ and $1 - \left(\frac{\theta}{\theta_{\min}}\right)^{-\eta}$, respectively; and the means of both shocks are set to 1.²⁸

Next, we calibrate the five country-specific parameters $\{\sigma, \eta, \delta, \xi, b\}$. These parameters controls many moments in our model, including the distribution of firms (such as the lumpiness of firm-level investment), the distribution of households (such as consumption inequality), the aggregate investment-to-capital ratio, national saving rate, the MPK, and real interest rate, and so on. In general, we choose parameter values to match the key moments in the data. Due to data limitations, some of the data moments in ROW are based on data from the OECD countries or the U.S. Our priority is to match the Chinese economy.

²⁷This parameter value of ψ together with other country-specific parameter values implies that the steady-state hours worked per week is 30% of the time endowment in the U.S. and 32% in China.

²⁸This implies the lower bounds $\varepsilon_{\min} = \frac{\sigma-1}{\sigma}$ and $\theta_{\min} = \frac{\eta-1}{\eta}$.

Our calibrations attempt to target the following moments for ROW: (i) an average annualized investment rate (I/K ratio) of 12%, (ii) an annual investment spike rate of 18%, (iii) a consumption Gini coefficient of 0.3, (iv) a national saving rate of 20% , and (v) an annual rate of pre-tax capital return (MPK) of 10%.

For China, the shape parameter σ in the Pareto distribution function takes the same value as that in ROW. The remaining four parameters $\{\eta, \delta, \xi, b\}$ are calibrated to target the following four moments of Chinese data: (i) an annual rate of return to fixed capital (MPK) of 20%, (ii) a household saving rate of 35%, (iii) a consumption Gini coefficient of 0.5, and (iv) the cross-country

ratio $\frac{\text{ROW's private credit-output ratio}}{\text{China's private credit-output ratio}} = 1.6$.²⁹

Table 2: Parameter Values

	China	ROW
β : discounting factor	0.99	0.99
α : capital share in production	0.4	0.4
δ : capital depreciation rate	0.0626	0.0341
ψ : coefficient of leisure in utility function	2.5	2.5
ξ : borrowing constraint on firm side	0.0080	0.0289
b : borrowing constraint on household side	0.0003	0.1035
σ : shape parameter for investment efficiency shock	1.5203	1.5203
η : shape parameter for preference shock	1.3735	2.1827
Parameters controlling for financial liberalization		
$\bar{\gamma}_k$: FDI adjustment cost	0.8385	
χ : curvature of FDI adjustment cost	1	
ρ_{γ_k} : AR(1) coefficient	0.9122	
$\bar{\gamma}_s$: bond-flow adjustment cost	0.0016	
τ : curvature in bond-flow adjustment cost	1	
ρ_{γ_s} : AR(1) coefficient	0.9703	

The remaining parameters are related to the cross-border adjustment costs for international capital flows. For the curvature parameters $\{\chi, \tau\}$, we set them to 1, so that the cost functions are quadratic. The parameters $\{\gamma_k, \gamma_s\}$ control the magnitudes of capital flows, therefore representing the extent of financial liberalization. To capture the gradualness of market integration, we assume $\{\gamma_{kt}, \gamma_{st}\}$ follow deterministic AR(1) processes:

$$\gamma_{kt} - \bar{\gamma}_k = \rho_{\gamma_k} (\gamma_{kt-1} - \bar{\gamma}_k), \quad (59)$$

$$\gamma_{st} - \bar{\gamma}_s = \rho_{\gamma_s} (\gamma_{st-1} - \bar{\gamma}_s). \quad (60)$$

²⁹Wen (2011) argues that the reported Gini coefficients for China are underestimated. He conjectures that income Gini in China is about 0.8 and the consumption Gini is about 0.5.

We then calibrate the values of $\{\bar{\gamma}_k, \bar{\gamma}_s, \rho_{\gamma_k}, \rho_{\gamma_s}\}$ so that the dynamic path of capital flows in the model closely match the Chinese data. In particular, the targeted series are Chinese net inward FDI (accumulated) and total foreign reserves from 1992 to 2010. We assume the processes of γ_{kt} and γ_{st} start with some initial values in 1992 and gradually achieve their long-run values $\bar{\gamma}_k$ and $\bar{\gamma}_s$. Table 2 summarizes all the calibrated parameters.

6.2 Steady-State Predictions

Table 3 reports the predictions of the model in the financial autarky and financial liberalization regimes. Columns 1 and 2 pertain to China and the ROW in the autarky regime. Columns 3 to 8 pertain to the two countries in the financial liberalization regime in which financial and fixed capital are internationally mobile.

In the autarky regime, China has a higher Tobin's q than ROW (2.1995 vs 1.1148), a higher annual return of fixed capital (21.9895% vs 9.6325%), but a lower real interest rate (1.4357% vs 4.0323%). All these predictions are due mainly to a relatively less-developed financial system in China than ROW.

Because of the cross-country spread in the rates of return to financial and fixed capital, financial liberalization between countries will induce China to hold negative foreign productive asset positions (FDI inflow) but positive financial asset positions (bonds outflow), with the former equal to -30% and the latter equal to 84% (as shares of GDP) in the long-run steady state. These values are about 25% and 33% larger than their counterparts in the real data,³⁰ indicating that the actual Chinese economy is not yet at its steady state in the financial liberalization regime.

Table 3. Steady States in Financial Autarky and Financial Liberalization

Country	Autarky		Only Financial Capital Flows		Only Fixed Capital Flows		Both Capital Flows	
	(1) China	(2) ROW	(3) China	(4) ROW	(5) China	(6) ROW	(7) China	(8) ROW
Return of capital (%)	21.9895	9.6325	22.3555	9.6248	21.6071	9.6375	22.0581	9.6304
Interest rate (%)	1.4357	4.0323	1.7754	4.0223	1.0903	4.0387	1.4986	4.0295
Tobin's q	2.1995	1.1148	2.1634	1.1151	2.2378	1.1145	2.1927	1.1149
Net foreign asset positions (%)	...	...	76.6031	-42.3428	-26.0278	16.0877	54.2133	-30.7928
Direct investment abroad (%)	...	...	0	0	-26.0278	16.0877	-29.5504	16.7844
Bonds (%)	...	...	76.6031	-42.3428	0	0	83.7638	-47.5772
Trade balances (%)	...	...	-3.0358	1.6781	5.6239	-3.4761	3.1928	-1.8135
Interest rate payments (%)	...	...	3.0358	-1.6781	0	0	3.3255	-1.8888

To better understand the different impacts of financial and fixed capital flows on each country's MPK and interest rate, we consider first partial liberalization scenarios by allowing only one type

³⁰By 2010, the accumulative net inward FDI of China was about 24% of GDP, and the net outward debt position was about 59% of GDP.

of capital (bonds or fixed capital) to move across borders. Columns 3 and 4 report the steady state in which only financial assets (bonds) are internationally mobile. The opening of bond markets induces financial capital outflow from China into ROW, which makes the interest rates converge across countries—the convergence is not 100% because of cross-border trading costs (home bias). As a result, the equilibrium interest rate in China increases from 1.4% in autarky to 1.8%, which further raises the domestic return of fixed capital from 21.99% to 22.36%. The situation in ROW is the opposite: The interest rate decreases from 4.03% in autarky to 4.02%, and the rate of return of fixed capital declines slightly from 9.63% in autarky to 9.62%. These above results confirm the previous analysis in section 5.4 that international bonds flow narrows the gap of country-specific interest rates but enlarges the gap in the rate of return to fixed capital.

Columns 5 and 6 report the situation when only fixed capital can move internationally. Fixed capital will flow from ROW to China because China has a higher MPK in autarky. In particular, FDI inflows increase the capital supply in China, thereby reducing China's domestic interest rate from 1.4% to 1.1%. The inward FDI also reduces the equilibrium return of fixed capital in China from 21.99% to 21.61%. In contrast, FDI outflows raise the interest rate in ROW from 4.03% in autarky to 4.04%, and pushes up ROW's MPK from 9.6325% to 9.6375%.

To summarize, financial capital outflow tends to increase the domestic interest rate and fixed capital return, whereas FDI inflow has the opposite effect. As a result, under the fully financial liberalization regime, both MPK and the interest rate do not change significantly from their autarky values, as shown in columns 7 and 8.

Since international capital flows are fully determined by the cross-country discrepancies in interest rate and MPK, the two types of capital flows reinforce each other. Namely, FDI inflows may cause financial capital outflows, and financial capital outflows in turn may cause FDI inflows. The line in Table 3 labeled "Net Foreign Asset Positions" quantitatively shows this point. When only bonds can be traded across countries, the financial capital outflow from China is about 77% of its GDP. When only fixed capital is allowed to move across countries, FDI inflows in China is 26% of its GDP. The corresponding ratios increase significantly when the two capital markets are both liberalized. The financial capital outflows in China become 84% of China's GDP, about 10% larger than that in partial liberalization. Meanwhile, the FDI inflows rise to 30% of China's GDP, which is also 10% more than that in partial liberalization.

Next we discuss the impact of capital flows on long-run trade balances (the bottom panel in Table 3). When only financial assets are mobile across countries, China will run trade deficits (-3% of GDP) in the long run despite that China has net financial capital outflows. In contrast, the U.S. (ROW) will run trade surplus (1.7% of GDP). These trade balances come entirely from interest payments on international bonds. However, when only fixed capital is mobile across countries,

China will run a trade surplus (5.6% of GDP) in the steady state while ROW will run trade deficits (-3.5% of GDP). These balances come entirely from capital gains from FDI positions: FDI outflows from ROW to China. Because the rate of return to FDI dominates the rate of return to financial assets, in the long run China maintains a trade surplus of 3.2% of its GDP while ROW (e.g., the U.S.) maintains a trade deficit of -1.8% of its GDP. Therefore, despite that FDI flows are smaller than financial asset flows in GDP shares, developed countries (such as the U.S.) can have permanent trade deficits with developing countries (such as China) because FDI payments from China are much larger than U.S. interest payments on its bonds.

6.3 Transitional Dynamics

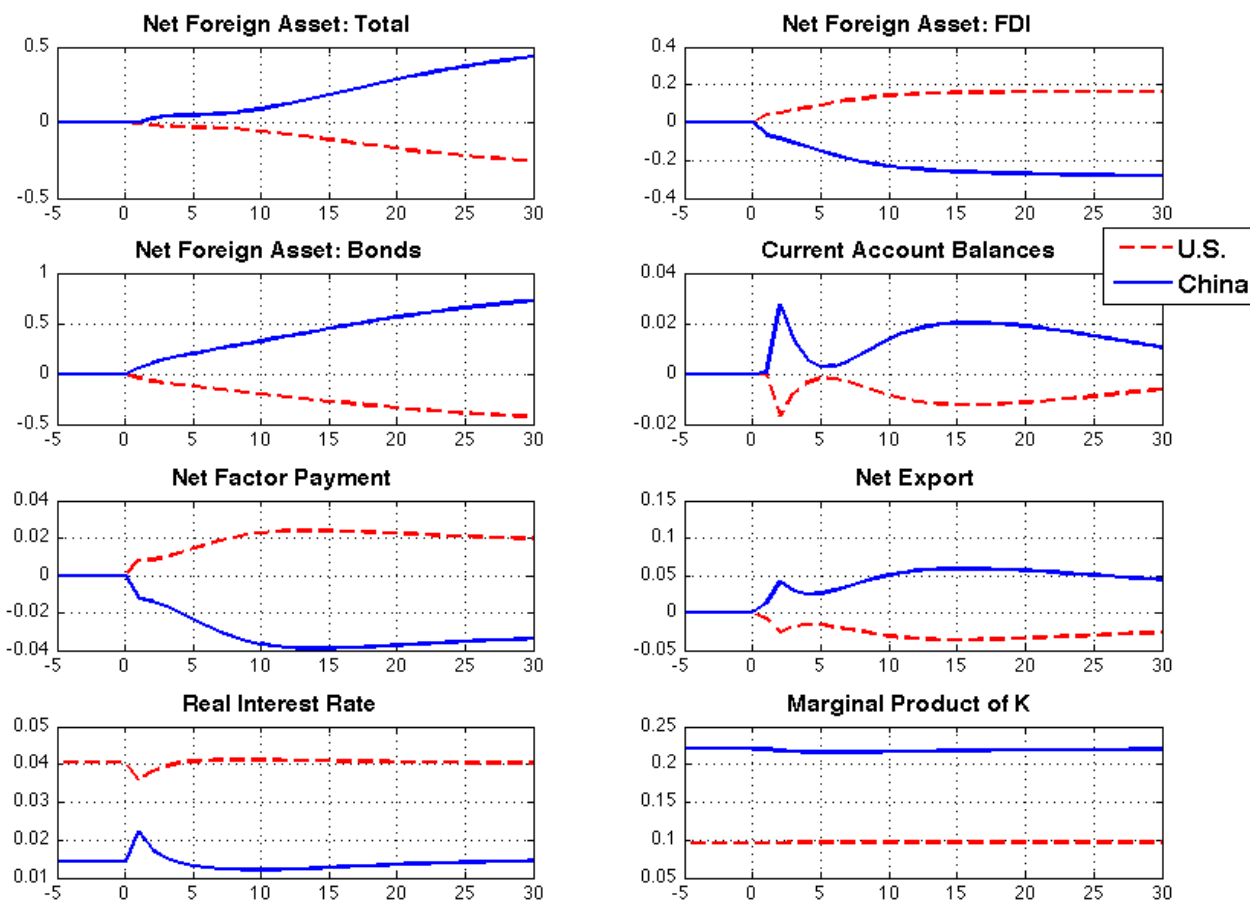


Figure 5. Transition Dynamics after Financial Liberalization.

Figure 5 shows the transitional dynamics of major aggregate variables when the model economy

opens up to financial liberalization (with both financial and fixed capital flows). The top panel in the right column and the second panel in the left column show a typical pattern of two-way capital flows: Financial assets leave China and flow into ROW (second panel on the left), while FDI leaves ROW and flows into China (top panel on the right). Because the volume of financial asset flows dominates that of FDI, the net foreign asset position is positive in China and negative in ROW (top left panel), suggesting global imbalances in capital flows.

Because of positive net capital outflows (financial plus fixed), China runs a trade surplus in the short run (second and third panels on the right column). In particular, the current account in China experiences sharp increases on impact and then decreases in the following years before increasing again. However, since FDI earns a much higher rate of return than bonds, China always receives negative income payments (third panel on the left). As a result, China runs a persistent and permanent trade surplus while ROW runs persistent and permanent trade deficits. Hence, our model suggests that the imbalanced world trade is sustainable as a long-run equilibrium. In addition, the bottom panels on both the right and the left show that the interest and the rate of return to fixed capital (MPK) are almost unaffected under two-way capital flows. This is so because FDI inflows and financial asset outflows have the opposite effect on the interest rate and the MPK, confirming the previous theoretical analysis.

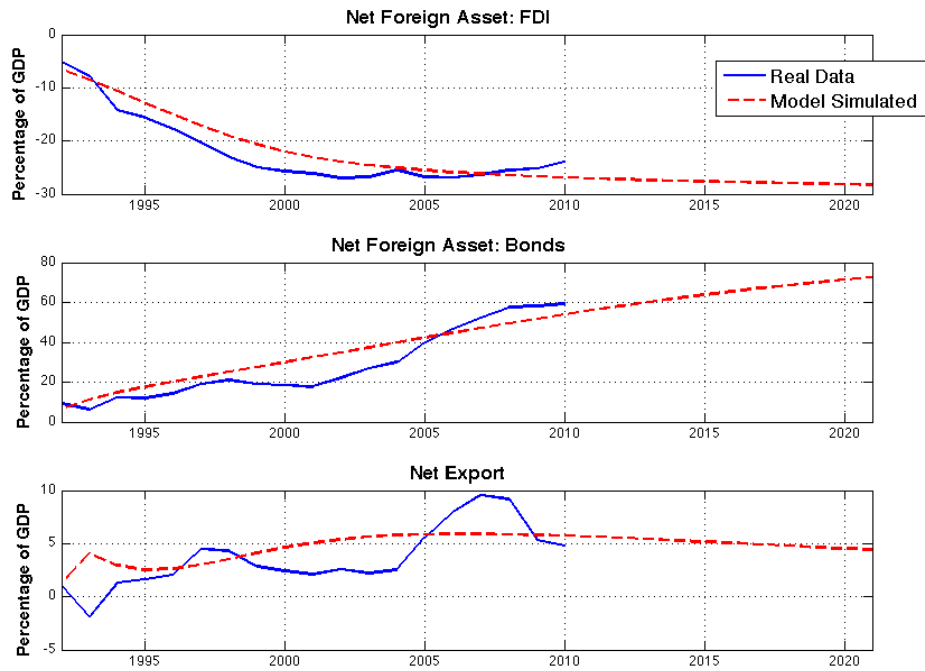


Figure 6. Net Foreign Asset Positions in China (model simulations vs real data).

Finally, Figure 6 compares the model-simulated paths of capital flows in the home country (dashed lines) and their counterparts in Chinese data (solid lines). The top panel shows net FDI inflows to the home country, the middle panel shows net financial asset outflows from the home country, and the bottom panel shows net exports of the home country. The simulated series closely track the long-run trends of the Chinese data, indicating that the model explains the dynamics of China's capital flows and trade imbalances quite well. Although our calibrations do not target the net exports, the simulated path tracks the trend in the data quite well. Moreover, the simulated series predict that in 2020 China's FDI inflow and foreign reserves (financial asset outflow) will reach the level of 80% and 75% of GDP in the long run, respectively. This will take another 10 years to accomplish from hereafter. The model also predicts that China's net exports peaked in 2007 and will gradually approach a steady-state level of 3.2% of GDP.

6.4 Welfare Implications

It is often argued, though mostly informally, that outward foreign direct investment (FDI) is synonymous for exporting jobs and thus detrimental to the home economy. On the other hand, inward FDI is beneficial for the host country because of technology transfers and increased employment opportunities. Even without technology transfers and an increased employment opportunity, FDI inflow is still widely believed to be beneficial to recipient countries because additional capital always brings additional output and labor income even after repaying for foreign capital's income shares.

To see whether and under what conditions this intuition indeed holds true, we use our two-country neoclassical growth model to examine welfare implications of outward FDI on the sourcing country and inward FDI on the recipient country when countries have symmetric technologies. It is found that under financial frictions, the welfare implications of FDI can be the opposite of what is widely perceived in the public. Namely, outward FDI is beneficial for the sourcing country whereas inward FDI is harmful to the recipient country. We call this negative welfare effect of inward FDI on the recipient country the immiserization effect of FDI.

The immiserization effect of FDI arises because (i) FDI inflows crowd out domestic capital formation by lowering the MPK and hence the marginal value of the firm, which exacerbates firms' borrowing constraints. (ii) Inward FDI reduces the rate of return to household savings by lowering the domestic interest rate, which tightens the borrowing constraints of the households. These effects lead to welfare losses. Under realistic parameterization of the model, these negative welfare effects strictly dominate the positive welfare effect arising from a higher labor income, thus leading to immiserization. In other words, although inward FDI increases labor income in the South, it decreases capital income. Under financial frictions, the latter effect dominates the former.

For the Sourcing country, in contrast, outward FDI does the opposite: It increases the MPK

and the interest rate, thus mitigating firms' borrowing constraints (by raising firms' value) and relaxing household borrowing constraints (by increasing the returns to saving). In addition, FDI outflows enable the sourcing country to glean a much higher rate of return to fixed capital than otherwise. These effect strictly dominates the loss of wage income due to capital outflows, leading to significant welfare gains.

We measure the welfare effect of financial liberalization by the percentage change of consumption that is required to make households indifferent between liberalizing capital markets and staying in autarky. In computing this measure, we take into account the welfare effects of the transition dynamics from autarky to liberalization. Specifically, we start with steady state in autarky and measure the percentage changes in consumption (λ) such that all households in a country are ex ante indifferent between two types of economies in expected lifetime utilities:

$$\frac{1}{1-\beta} \int [\theta \log [(1+\lambda) c^A] - \psi n^A] dF(\theta) = E \sum_{t=0}^{\infty} \left[\int \theta_t(i) \log c_t(i) - \psi n_t(i) di \right], \quad (61)$$

where the LHS denotes the lifetime expected utility of staying in autarky and the RHS that of moving to financial liberalization, with c^A and n^A on the LHS denoting the consumption and labor supply in autarky, and c_t and n_t on the RHS denoting the dynamic paths of consumption and labor supply after financial liberalization.

Table 4. Welfare Gains (%)						
Country	Only Financial		Only Fixed		2-Way Flow	
	(1)	(2)	(3)	(4)	(5)	(6)
	China	ROW	China	ROW	China	ROW
Benchmark						
Consumption	0.23	0.20	-0.08	0.75	0.06	1.05
Add Leisure	0.92	0.03	-1.09	1.40	-0.17	1.53
Large Openness of Bonds Market						
Consumption	0.38	0.29	-0.08	0.75	0.17	1.19
Add Leisure	1.34	0.05	-1.09	1.40	0.25	1.59

Table 4 reports the welfare effects of financial liberalization. Consider first the case with only financial capital flows across countries in our benchmark model (the top panel, columns 1 and 2). Financial capital flows benefit both countries, with the sourcing country (China) gains more than the recipient country (ROW). If we ignore the leisure margin, China gains slightly more than ROW (the increase in lifetime consumption is 0.23% for China and 0.20% for ROW). However, since an outflow of financial capital from China will decrease the domestic labor supply and increase foreign labor supply, leisure also rises in China and declines in ROW. As a result, if the leisure margin is taken into account, China's welfare gain is significant (0.92%) while that of ROW is insignificant (it is reduced to 0.03%).

Next, consider the case with only fixed capital flows across countries (columns 3 and 4). The welfare implication in this case is significantly different from the former case. In particular, although the sourcing country of FDI gains unambiguously (0.75% of consumption), the recipient country loses (-0.08% of consumption). If the leisure margin is taken into account, both the gains and the losses are further magnified (with a gain of 1.4% and a loss of -1.1%, respectively). As discussed previously, inward FDI into China increases the aggregate capital supply and thus decreases China's MPK and the interest rate. This hurts Chinese firms and Chinese savers by lowering the rate of return on bonds and domestic equity holdings. The opposite is true for ROW. In addition, since FDI inflows increase aggregate labor demand in China, leisure in China decreases while that in ROW increases. But the gain in labor income in China is not large enough to offset the losses along other dimensions, explaining the large immiserization effect when the leisure margin is included.

Finally, consider the case with both financial and fixed capital flows across countries (columns 5 and 6 in Table 4). Since the welfare effects of FDI flows dominate those of financial capital flows, the overall welfare gain for ROW is significant (1.05% of consumption without leisure and 1.53% with leisure), while China has a mild gain of 0.06% without considering leisure and a loss of -0.17% after taking leisure into account.

One implication from the welfare analysis is that with financial frictions a country can benefit unambiguously from capital outflows but may suffer from capital inflows (especially with respect to FDI inflows). Therefore, if financial capital flows significantly dominate FDI flows, it is possible that both China and ROW can gain from financial liberalization. To confirm this conjecture, we reduce the cross-border adjustment cost for bond trading by setting γ_s to 0.001, implying that the steady-state bond position in China is about 120% of GDP. The lower panel in Table 4 (labeled "Large Openness in Bond Market") shows that China can have welfare gains under two-way capital flows (regardless of the leisure margin), although the gain is significantly smaller than that of the U.S. because of the different nature of the capital flows involved.

7 Conclusions

International capital flows between the North and South are two-way instead of one-way flows, with fixed capital flowing from rich to poor countries and financial capital flowing in the opposite direction. We augment the standard neoclassical growth model with two wedges (a saving wedge and an investment wedge) to quantitatively explain the magnitude of the two-way capital flows. We show that financial frictions—the lack of an efficient banking-credit system in particular—can lead to insufficient investment on the firm side (the investment wedge) and excessive saving on the household side (the saving wedge). Consequently, fixed capital is scarcer while financial capital

is relatively abundant in the South, creating a gap between the MPK and the real interest rate both within and across countries. This gap in rates of capital returns drives the observed two-way capital flows between the North and the South.

The main advantages of our model are therefore fourfold: (i) the ability to make a clear distinction between financial capital flows and fixed capital flows in a full-fledged neoclassical growth model with double-heterogeneous agents; (ii) the ability to disentangle the financial interest rate and the MPK through Tobin's q theory and show that the market rate of return to fixed capital can be over 20% a year in equilibrium despite low interest rate (as in China); (iii) the ability to explain China's excessively high saving rate (despite low interest rate) and its massive trade imbalances with the ROW; and (iv) the ability to provide a tractable tool for evaluating the welfare consequences of the two fundamentally different forms of capital flows.³¹

In contrast to the existing approaches of studying FDI (e.g., MQR 2009), which model FDI as households' portfolio choices through financial equity investment, we model FDI as firms' production decisions through international factor allocation. Therefore, instead of creating the differential rates of return between bonds and FDI through equity premium, we achieve this through Tobin's q theory—a standard approach in line with the neoclassical investment theory.

Our main findings challenge the conventional wisdom in the global imbalance literature on several grounds: (i) Our model predicts that permanent global trade imbalances are sustainable (with the North running deficits and the South running surpluses). (ii) Our quantitative analysis shows that the impact of massive financial capital flows from emerging economies to the developed world is quantitatively small and negligible on the world interest rate, in sharp contrast to the conjecture of Bernanke (2005). (iii) We also show that FDI flows driven by differential returns to fixed capital across borders (due to financial frictions) benefit the sourcing country and immiserize the recipient country.

Another implication of our analysis is that the thrust of reducing global imbalances (for better or worse) hinges neither on adjusting the exchange rates nor on capital account liberalization.³² Rather, it hinges on improving emerging economies' banking system (i.e., reducing borrowing constraints facing both households and firms) so that household savings can be channeled more effectively to domestic production sector.

However, our model does not fully resolve the "allocation puzzle" of Gourinchas and Jeanne

³¹Our infinite-horizon model is tractable despite heterogeneous households and heterogeneous firms. This double heterogeneity would have made most dynamic models (even the two-period overlapping generation models) intractable. However, our model permits closed-form solutions for households' and firms' decision rules despite infinitely lived agents and a large state space involving distinct distributions of households and firms across countries. Welfare gains can then be computed analytically. In particular, we are able to decompose the welfare gains into a consumption and a leisure margin under either financial or fixed capital flows.

³²Capital account liberalization effectively means the reduction in the costs of international capital flows. Our model predicts that this would only generate more global imbalances if financial frictions exist that enhance the two-way capital flows.

(2011) because we did not show why countries with faster growth attract less international capital. To fully resolve the allocation puzzle, we need to introduce TFP growth and show that the wedge between financial interest rate and the rate of return to fixed capital is an increasing (rather than decreasing) function of the growth rate. This is left for future work (see Wen, 2011, for some critical progress in this direction).

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A Appendix A

A.1 Proof of Proposition 1

Since the optimal labor demand in the domestic and foreign markets is given, respectively, by $N_{jt}^h = \left(\frac{1-\alpha}{W_t^h}\right)^{1/\alpha} (1-u_{jt}^h) K_{jt}^h$ and $X_{jt}^h = \left(\frac{1-\alpha}{W_t^f}\right)^{1/\alpha} u_{jt}^h K_{jt}^h$, the CRS production technology implies that the marginal product of capital for domestic and foreign business can be expressed as $r_t^h = \alpha \left(\frac{1-\alpha}{W_t^h}\right)^{\frac{1-\alpha}{\alpha}}$ and $r_t^f = \alpha \left(\frac{1-\alpha}{W_t^f}\right)^{\frac{1-\alpha}{\alpha}}$, respectively. After substitution, the profit-maximization problem of the firm can then be simplified to

$$\begin{aligned} \Pi_{jt}^h &= \max_{u_{jt}^h} \left[r_t^h (1 - u_{jt}^h) + r_t^f u_{jt}^h - \gamma_k \frac{(u_{jt}^h)^{1+\chi}}{1+\chi} \right] K_{jt}^h \\ &\equiv R_{kt}^h K_{jt}^h. \end{aligned} \quad (62)$$

The optimal FDI decision variable u_{jt}^h can be solved as

$$u_{jt}^h = \begin{cases} 0 & \text{if } r_t^f \leq r_t^h \\ \left(\frac{r_t^f - r_t^h}{\gamma_k} \right)^{\frac{1}{\chi}} & \text{if } r_t^f > r_t^h \end{cases}. \quad (63)$$

Substituting the optimal FDI decision rules into the profit function gives equation (21). Q.E.D.

A.2 Proof of Proposition 2

For each period t , after the realization of ε_{jt}^h , firm j chooses optimal investment level to solve following problem

$$\max_{I_{jt}^h} R_{kt}^h K_{jt}^h - I_{jt}^h + q_t^h \left[(1 - \delta) K_{jt}^h + \varepsilon_{jt}^h I_{jt}^h \right]$$

subject to (11), (12) and (24). The objective function can be simply rewritten as $[R_{kt}^h + q_t^h (1 - \delta)] K_{jt}^h - (1 - q_t^h \varepsilon_{jt}^h) I_{jt}^h$. Define the cutoff $\bar{\varepsilon}_t^h \equiv 1/q_t^h$. For the $\varepsilon_{jt}^h > \bar{\varepsilon}_t^h$, firm j will invest the maximum amount that it can achieve, therefore (11) and (24) are binding—that is, $I_{jt}^h = q_t^h \varepsilon_{jt}^h K_{jt}^h + R_{kt}^h K_{jt}^h$. For the $\varepsilon_{jt}^h \leq \bar{\varepsilon}_t^h$, firm j will choose the minimum investment, i.e., the zero level due to the irreversibility constraint. By inserting the optimal investment into (23), we can easily obtain the marginal value

of the firm $v_t^h = R_{kt}^h + (1 - \delta) q_t^h + (q_t^h \xi^h + R_{kt}^h) \Omega(q_t^h)$, where $\Omega(q_t^h) \equiv \int_{\varepsilon_{jt}^h > \bar{\varepsilon}_t^h} (q_t^h \varepsilon_{jt}^h - 1) d\Phi$ with $\Omega'(q_t^h) > 0$. Furthermore, from the definition $q_t^h \equiv \rho^h E_t \frac{\Lambda_{t+1}^h}{\Lambda_t^h} v_{t+1}^h$, the evolution of q_t^h is thus

$$q_t^h = \rho^h E_t \frac{\Lambda_{t+1}^h}{\Lambda_t^h} \left[R_{kt+1}^h + (1 - \delta) q_{t+1}^h + (q_{t+1}^h \xi^h + R_{kt+1}^h) \Omega(q_{t+1}^h) \right].$$

Q.E.D.

A.3 Proof of Proposition 3

Denote $\{\pi_{it}^h, \mu_{it}^h, \lambda_{it}^h\}$ as the Lagrangian multipliers for constraints (1), (2), and (4), respectively. The first-order condition for labor is

$$W_t^h \int \lambda_{it}^h dF(\theta) = \psi^h. \quad (64)$$

Since labor is determined in the first subperiod of t before observing θ_{it} , the household knows only the expected value of λ_{it}^h when making labor supply decisions. The first-order conditions for $\{c_{it}^h, s_{it+1}^h, \tilde{s}_{it+1}^h, a_{it+1}^h\}$ are given, respectively, by

$$\frac{\theta_{it}^h}{c_{it}^h} = \lambda_{it}^h, \quad (65)$$

$$\lambda_{it}^h - \pi_{it}^h = \beta E_t \left(\lambda_{it+1}^h R_{bt}^h \right), \quad (66)$$

$$\lambda_{it}^h - \pi_{it}^h - \mu_{it}^h = \beta E_t \left[\lambda_{it+1}^h \left(R_{bt}^f - \gamma_s \left(\tilde{s}_{it+1}^h \right)^\tau \right) \right], \quad (67)$$

$$\lambda_{it}^h - \pi_{it}^h = \beta E_t \left(\lambda_{it+1}^h \frac{D_{t+1}^h + Q_{t+1}^h}{Q_t^h} \right). \quad (68)$$

Note that by arbitrage, bonds and equities must yield the same expected rate of return. Hence, equations (66) and (68) imply $R_{bt}^h = \frac{D_{t+1}^h + Q_{t+1}^h}{Q_t^h}$ in the absence of aggregate uncertainty.³³ Rewriting this relationship, we obtain equation (29). From equations (66) and (67), we can obtain equation (28). Q.E.D.

³³With aggregate uncertainty, the result holds to a first-order approximation.

A.4 Proof of Proposition 4

For simplicity, here we drop the superscript h . We now first prove that the total wealth $H_{it} = (Q_t + D_t) a_{it} + W_t n_{it} + s_{it} + \tilde{s}_{it} - \gamma_s (\tilde{s}_{it})^\tau / (1 + \tau)$ is degenerated. In the second subperiod, the households' consumption, saving, and stock holdings can be written as a function of its own wealth H_{it} , liquidity shock θ_{it} , and aggregate variables. We hence have

$$\lambda_{it} = \frac{\theta_{it}}{c_{it}} = \frac{\theta_{it}}{c_t(H_{it}, \theta_{it})} \quad (69)$$

Equation (66) can then be written as

$$\begin{aligned} \frac{\theta_{it}}{c_t(H_{it}, \theta_{it})} &= \beta R_{bt} E_i [\lambda_{it+1}] + \pi_{it} \\ &= \beta R_{bt} \frac{\psi}{W_{t+1}} + \pi_{it}, \end{aligned} \quad (70)$$

where the second line has used equation (64). Define $\bar{\theta}_{it}$, such that

$$\frac{\bar{\theta}_{it}}{H_{it} + B_t} = \beta R_{bt} \frac{\psi}{W_{t+1}}, \quad (71)$$

Since $c_{it} \leq H_{it} + B_t$, we must have $\frac{\theta_{it}}{c_t(H_{it}, \theta_{it})} \geq \frac{\bar{\theta}_{it}}{H_{it} + B_t}$ for $\theta_{it} \geq \bar{\theta}_{it}$. By (70) and (71), we must have $\pi_{it} > 0$. Or the borrowing constraint (1) binds, and the household's consumption is $c_{it} = H_{it} + B_t$. On the other hand, $\pi_{it} = 0$, we must have

$$\frac{\theta_{it}}{c_t(H_{it}, \theta_{it})} = \frac{\bar{\theta}_{it}}{H_{it} + B_t} \quad (72)$$

or $c_{it} = (H_{it} + B_t) \frac{\theta_{it}}{\bar{\theta}_{it}}$. Since $c_{it} < H_{it} + B_t$, we must have $\theta_{it} < \bar{\theta}_{it}$. Finally, using the consumption rule derived above, we rewrite equation (64) as

$$\frac{W_t}{\psi} \left[\int_{\theta < \bar{\theta}_{it}} \frac{\bar{\theta}_{it}}{H_{it} + B_t} f(\theta) d\theta + \int_{\theta > \bar{\theta}_{it}} \frac{\theta}{H_{it} + B_t} f(\theta) d\theta \right] = 1. \quad (73)$$

Equation (71) and (73) jointly determine $\bar{\theta}_{it}$ and H_{it} . It is evident that H_{it} and $\bar{\theta}_{it}$ depend only on aggregate variables in the economy; hence we have $H_{it} = H_t$ and $\bar{\theta}_{it} = \bar{\theta}_t$. By dropping the subscript i from equation (71), we obtain equation (33). If we write equation (73) more compactly and drop the subscript i , we obtain equation (34). The rest of equations (31) and (32) are straightforward to obtain. Q.E.D.

A.5 Proof of Proposition 7

We proceed with our proof in two steps. First, we show that there exist parameter values of financial development such that the home country in autarky has higher MPK and a lower interest rate. Then we show under these parameter values, the home country, in financial liberalization, holds a positive position in financial capital and a negative position in fixed capital.

Lemma 1 *Suppose the home country has tighter borrowing constraints on the firm side, that is, $\xi^h < \xi^f$, then for any b^f , there exist $\underline{b}$ and $\bar{b}$ such that if $b^h \in (\underline{b}, \bar{b})$,³⁴ in the financial autarky regime, the home country has higher MPK and a lower real interest rate.*

Proof of Lemma 1. In the financial autarky regime, the equilibrium return of capital r^ℓ (MPK) (or the inverse $\frac{K}{Y}$ ratio) and the real interest rate R_b^ℓ are determined by (53) and (54). In the autarky equilibrium r^ℓ and R_b^ℓ are the functions of financial developments $\{\xi^\ell, b^\ell\}$, which we denote as $r_{Aut}(\xi^\ell, b^\ell)$ and $R_{Aut}^*(\xi^\ell, b^\ell)$ respectively. As Proposition 6 shows, we have $\frac{\partial r_{Aut}(\xi^\ell, b^\ell)}{\partial b^\ell} > 0$, $\frac{\partial r_{Aut}(\xi^\ell, b^\ell)}{\partial \xi^\ell} < 0$ and $\frac{\partial R_{Aut}^*(\xi^\ell, b^\ell)}{\partial b^\ell} > 0$. Therefore, there exists $\bar{b}$ satisfying

$$R_{Aut}^*(\xi^f, b^f) = R_{Aut}^*(\xi^h, \bar{b}), \quad (74)$$

such that for any $b^h < \bar{b}$, we must have $R_{Aut}^*(\xi^f, b^f) > R_{Aut}^*(\xi^h, b^h)$.³⁵ There also exists $\underline{b}$ satisfying

$$r_{Aut}(\xi^f, b^f) = r_{Aut}(\xi^h, \underline{b}), \quad (75)$$

such that for any $b^h > \underline{b}$,³⁶ we must have $r_{Aut}(\xi^h, b^h) > r_{Aut}(\xi^f, b^f)$. Note that $\bar{b} > \underline{b}$ because of $\frac{\partial R_b^\ell(\xi^\ell, b^\ell)}{\partial R_b} > 0$ and $\frac{\partial R_b^\ell(\xi^\ell, b^\ell)}{\partial \xi} < 0$. Q.E.D.

Lemma 2 *Suppose the home country has tighter borrowing constraints on the household side, i.e. $b^h < b^f$, and idiosyncratic investment efficiency ε follows the Pareto distribution, then for any ξ^f , there exists $\bar{\xi}$ such that if $\xi^h < \bar{\xi} < \xi^f$, in the financial autarky regime, the home country has higher MPK and a lower real interest rate.*

Proof of Lemma 2. From (48), the Pareto distribution of ε implies the MPK (or Y/K) in the autarky regime is a linear function of q . Furthermore, (54) implies R_{Aut}^* depends only on b and does not depend on ξ . Thus, according to Proposition 6, $b^h < b^f$ implies $R_{Aut}^*(b^h) < R_{Aut}^*(b^f)$.

³⁴Of course, $\bar{b}$ and $\underline{b}$ are the functions of ξ^h, ξ^f and b^f . Without risk of confusion, here we do not express them explicitly as $\bar{b}(\xi^h, \xi^f, b^f)$ and $\underline{b}(\xi^h, \xi^f, b^f)$.

³⁵If we assume the investment efficiency shock follows Pareto distribution, it can be shown that the R_{Aut}^* does not depend on ξ , therefore $\bar{b}$ is simply b^f . That is, the higher level of financial development of foreign country on the household side induces a higher interest rate.

³⁶Note that since $\xi^h < \xi^f$, $\frac{\partial r_{Aut}(\xi^\ell, b^\ell)}{\partial \xi^\ell} < 0$ implies $\underline{b} < b^f$.

On the other hand, similar to the proof of Lemma 1, there exists $\bar{\xi}(\xi^f, b^f, b^h)$ satisfying

$$r_{Aut}(\xi^f, b^f) = r_{Aut}(\bar{\xi}, b^h) > r_{Aut}(\xi^f, b^h) \quad (76)$$

such that for any $\xi^h < \bar{\xi} < \xi^f$, we must have $r_{Aut}(\xi^h, b^h) > r_{Aut}(\xi^f, b^f)$. Q.E.D.

We now turn to prove Proposition 7 with one of the following conditions: (i) $\xi^h < \xi^f$ and $b^h \in (b, \bar{b})$, as stated in Lemma 1; or (ii) $b^h < b^f$, $\xi^h < \bar{\xi} < \xi^f$ and ε follows Pareto distribution, as stated in Lemma 2. The pattern of two-way capital flows requires us to show that in the liberalization regime interest rates satisfy $R_b^f > R_b^h$ and MPKs satisfy $r^h > r^f$. We proceed with the proof by ruling out all the complementarity relationships.

First, we show $R_b^f = R_b^h$ is impossible. In this case, there is no financial capital flow across countries. Since $\mathbb{R}(R_b, \xi)$ is decreasing in ξ and $\xi^h < \xi^f$, we must have $R_k^h > R_k^f$ and $r^h > r^f$.³⁷ The higher MPK in home country attracts FDI from foreign country, i.e. $u^f > 0$. FDI inflow will shift the capital supply downwardly.³⁸ Consequently, FDI inflow reduces the interest rate in the home country and raises the interest rate in the foreign country. This means, compared with to the autarky equilibrium, we have $R_b^f > R_{Aut}^*(\xi^f, b^f) > R_{Aut}^*(\xi^h, b^h) > R_b^h$, which contradicts $R_b^f = R_b^h$.

Second, we show $r^h = r^f$ is impossible. In this case, there is no FDI flow across countries, and $R_k^h = r^h = R_k^f = r^f$. Under the parameter values satisfying Lemma 1 or 2, we must have $R_b^h < R_b^f$ since $\mathbb{R}(R_b, \xi)$ is decreasing in ξ and increasing in R_b .³⁹ The higher interest rate in the foreign country attracts bonds inflow, which shifts the capital supply curve in the foreign country downward. In contrast, the bonds outflow moves the capital supply curve in the home country upward.⁴⁰ As a result, compared with the autarky regime, MPK in the home country increases and MPK in the foreign country falls. Therefore we have $r^h > r_{Aut}(\xi^h, b^h) > r_{Aut}(\xi^f, b^f) > r^f$, which is a contradiction with $r^h = r^f$.

Third, we show $R_b^f < R_b^h$ and $r^h > r^f$ is impossible. In this case, the home country experiences both FDI and bonds inflows, both of which shift the capital supply curve downward and thus reduce

³⁷Thus, we have already ruled out two combinations: $R_b^f = R_b^h$ and $r^h < r^f$ or $R_b^f = R_b^h$ and $r^h = r^f$.

³⁸More specifically, in this case, the capital supply curve in the home country (Eqn. 51) takes the form $(1 - \alpha)(1 + \kappa u^f) \frac{Y^h}{K^h} = \left(\frac{1}{1 - \Psi^h} - R_b^h\right) q^h + \frac{\Psi^h}{1 - \Psi^h} q^h b^h$. Since $\kappa u^f > 0$, compared with the autarky regime, the supply curve shifts downward.

³⁹Thus we rule out the combination $r^h = r^f$ with $R_b^h \geq R_b^f$.

⁴⁰More specifically, in this case, the capital supply curve in the home country (Eqn. 51) takes the form $(1 - \alpha) \frac{Y^h}{K^h} = \left(\frac{1}{1 - \Psi^h} - R_b^h\right) q^h + \frac{\Psi^h}{1 - \Psi^h} q^h b^h + \left[\frac{1}{1 - \Psi^h} - \left(\frac{\tau}{1 + \tau} R_b^f + \frac{1}{1 + \tau} R_b^h\right)\right] \frac{\tilde{S}^h}{K^h}$. Since the last term on the RHS is greater than zero, compared with the autarky regime, the supply curve shifts upward.

the interest rate: $R_b^h < R_{Aut}^*(\xi^h, b^h)$. In contrast, the FDI and bonds outflows in the foreign country shift both capital demand and supply curves upward.⁴¹ As a result, the interest rate in foreign country increases, i.e., $R_b^f > R_{Aut}^*(\xi^f, b^f)$. Since with the parameter values satisfying Lemma 1 or 2, we have $R_{Aut}^*(\xi^h, b^h) < R_{Aut}^*(\xi^f, b^f)$, and thus we must have $R_b^h < R_b^f$, which contradicts $R_b^f < R_b^h$. With the same logic, we can show $R_b^f > R_b^h$ and $r^h < r^f$ is impossible as well.

Hence, the home country in the fully liberalization regime has higher MPK and a lower interest rate. Consequently, the home country will hold a positive position in fixed capital and a negative position in financial capital. Q.E.D.

Appendix B: Data

B1. U.S. net positions of direct investment abroad relative to China (dashed line in Figure 1a). The Bureau of Economic Analysis (BEA) produces comprehensive statistics on U.S. direct investment abroad through the mandatory surveys. U.S. direct investment abroad is defined as ownership by a U.S. investor of at least 10 percent of a foreign business. Direct investment position statistics are stocks and are cumulative; they measure the total outstanding level of U.S. direct investment abroad at year end. The series used in our paper is the item "Position of direct investment abroad on a historical-cost basis" from the BEA website.⁴²

B2. U.S. net positions in debt instruments relative to China (solid line in Figure 1a). The United States collects data on cross-border portfolio investments through the Treasury International Capital (TIC) reporting system. Cross-border portfolio investments include foreign holdings of U.S. long-term and short-term securities, and U.S. holdings of foreign long-term and short term securities. In our paper, we define the U.S. net positions in debt relative to China as the U.S. holdings of China's long-term and short-term debt net of China's holdings of U.S. long-term and short-term debt. Therefore, the negative value indicates net inflows of financial capital toward the U.S.

B3. China's net position of financial capital investment. The series consists of the total net international reserve (excluding gold reserve) and the net security investments (equity+debt) which represents portfolio investments. Data source: CEIC. Dividing this series by China's nominal GDP gives the solid line in Figure 1b.⁴³

B4. China's net position of direct investment abroad. The series consists of the cumulative

⁴¹In particular, the FDI outflow simultaneously shifts capital demand and supply upward. The bonds outflow only shifts the capital supply upward.

⁴²Comparing to the U.S. direct investment to China, the amount of foreign investment from China to U.S. is negligible, we use the former series to represent U.S. net position of direct investment abroad relative to China.

⁴³China's GDP is measured in U.S. dollars. More specifically, we transform China's nominal GDP by multiplying the annual exchange rate. Since RMB experienced a sharp devaluation starting from 2006, to avoid the valuation effect, we replaced the exchange rates in 2006 to 2010 by the value at 2005.

outward direct investment flows minus the cumulative inward direct investment flows. Data source: CEIC. By dividing this series by China's nominal GDP, we get the dashed line in Figure 1b.

B5. Rate of return to fixed capital (top panel in Figure 2). Here we briefly illustrate the method and data used in our calculations. Bai et al. (2006) use the following formula to calculate the real rate of return to capital $r(t)$:

$$r(t) = \frac{\alpha(t)}{P_K(t)K(t)/[P_Y(t)Y(t)]} + [\hat{P}_K(t) - \hat{P}_Y(t)] - \delta(t), \quad (A1)$$

where $\alpha(t)$ is the share of payments to capital; $P_K(t)K(t)$ and $P_Y(t)Y(t)$ are capital stock and GDP in current prices, respectively; $\hat{P}_K(t)$ and $\hat{P}_Y(t)$ are the growth rate of investment price deflator and GDP deflator, respectively; $\delta(t)$ is the depreciation rate. For China's capital return $r(t)$, we use the updated data to extend Bai's series to more recent years. For the counterpart of the United States, we use the same method. In particular, we compute the capital return for the nonfinancial corporate business in private sector. We also exclude the residential sectors; so $\alpha(t)$ is the capital share in U.S. nonfinancial corporate business defined as $1 - \frac{\text{Compensation of employees}}{\text{Value added}}$. Both series are from "Table 1.14. Gross Value Added of Domestic Corporate Business in Current Dollars and Gross Value Added of Nonfinancial Domestic Corporate Business in Current and Chained Dollars" (BEA). $P_K(t)K(t)$ is the nonresidential capital stock (equipment and software plus structures) in current costs in nonfinancial corporate business, expressed in billions of dollars. Data are from "Table 4.1. Current-Cost Net Stock of Private Nonresidential Fixed Assets by Industry Group and Legal Form of Organization". $\delta(t)$ is the depreciation rate in U.S. private nonfinancial corporate business, defined as $\frac{\text{consumption of capital}}{\text{Capital Stock}}$. The data source is the same as $\alpha(t)$. $\hat{P}_Y(t)$ is the growth rate of GDP deflator, $\hat{P}_K(t)$ is the growth rate of Gordon price index for investment goods. The Gordon price index measures prices of a bunch of investment goods by quality adjustment; for details, see Liu, Wang and Zha (2011). For the alternative calculation of the return of capital, we follow the simple definition in Poterba (1998) as (Profits before tax with IVA plus CCAdj + Net interest payments)/Capital stock, the data source is the same as $\alpha(t)$. Note that our calculated series is slightly higher than Poterba's results (only up to the data before 1996); this is probably because we do not include inventory and land in our capital stock definition.

B6. Real interest rate (bottom panel in Figure 2). The annual lending rate in real terms, as downloaded from World Development Indicators (WDI).

B7. Private credit-to-GDP ratio (Figure 3). The data are downloaded from the World Development Indicator (WDI), defined as the ratio of domestic credit to private sectors and the GDP. It is a traditional indicator capturing one of the most important functions of financial intermediaries—credit allocation.

B8. Components of the U.S. direct investment abroad and Chinese inward FDI.

According to the BEA definition, foreign direct investment flows consists of four components:

- (1) **Equity investment**, which is the difference between equity increases and equity decreases. Equity increases arise from
 - (a) parents' establishments of new affiliates,
 - (b) payments by parents to unaffiliated parties for the purchase of capital stock or other equity interests when they acquire an existing business,
 - (c) payments made to acquire additional ownership interests in affiliates,
 - (d) capital contributions to affiliates. Equity decreases are the funds parents receive when they reduce their equity interest in their affiliates.
- (2) **Intercompany debt investment**, which results from changes in net outstanding loans between parents (or for inward investment, other foreign parent group members) and their affiliates, including loans by parents to affiliates and loans by affiliates to parents.
- (3) **Reinvested earnings** (without current-cost adjustment), which are the parents' share of the current-period operating earnings of their affiliates, less distributions of earnings by affiliates to their parents.
- (4) Various **valuation adjustments** to the historical-cost position are made to account for the differences between changes in the historical-cost positions, which are measured at book value, and direct investment financial flows, which are measured at transaction value. (Unlike the positions on current-cost and market-value bases, the historical-cost position is not usually adjusted to account for changes in the replacement cost of the tangible asset of affiliates or in the market value of parent companies equity in affiliates.)

If we look only at the first 3 components, only items (b) and (c) in Equity investment correspond to the FDI in Mendoza et al. (2011). Items (a) and (d) in Equity investment, as well as **Intercompany debt investment + Reinvested earnings**, in our view, correspond to the definition of FDI in our model. In particular, the change of FDI (or U.S. FDI outflow) in our model can be expressed as

$$\Delta FDI_t = u_t^f K_t^f - u_{t-1}^f K_{t-1}^f,$$

where the total earnings from FDI is $r_t^h u_t^f K_t^f$, which consists of reinvested earnings (RE_t) and earnings distributed to parents (ED_t). Therefore, ΔFDI_t can be further expressed as

$$\Delta FDI_t = RE_t + \left[ED_t - r_t^h u_t^f K_t^f + \left(u_t^f K_t^f - u_{t-1}^f K_{t-1}^f \right) \right].$$

The first term is reinvested earnings; the second term can be treated as **(a)+(d)+(2)+(3)**.

Therefore, $\frac{(a)+(d)+(2)+(3)}{(1)+(2)+(3)}$ measures the fraction of FDI captured by our model. However, the BEA has only the series of equity investment, so we can calculate only the ratio $\frac{(2)+(3)}{(1)+(2)+(3)}$, which tends to understate the role of the form of FDI defined in our model. Collecting the relevant data and calculating the ratio $\frac{(2)+(3)}{(1)+(2)+(3)}$ for U.S-China FDI flows gives 0.76.⁴⁴ As a robustness check, we also calculate the ratio $\frac{(2)+(3)}{(1)+(2)+(3)}$ for the total FDI outflow from U.S. to all countries and the value is about 0.62.⁴⁵

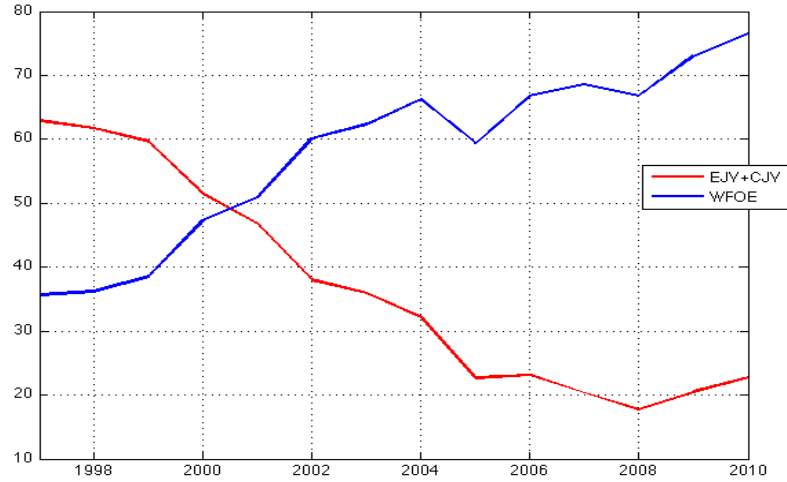


Figure A1. Percentage Shares of FDI Inflows by Type (data source: CEIC).

According to the ownership of foreign-invested projects in China, the FDI inflows can be divided into four main categories: equity joint ventures (EJVs), cooperative operation enterprises or contractual joint ventures (CJVs), wholly foreign-owned enterprises (WFOs), and others.⁴⁶ EJVs and CJVs both involve joint investment by Chinese and foreign partners, the main difference between these two types of FDI is the arrangement for sharing profit and losses. WFOs are the enterprises whose ownerships fully belong to foreigners. According to the above definitions, WFOs largely

⁴⁴The series used are from U.S. Direct Investment Abroad, i.e. FDI outflow from U.S. to China. Since FDI outflow from China to U.S. is negligible and has very limited observations, we use the former series to represent net FDI flows between two countries. Next, we calculate the sum of each item. For instance, we sum (3), the reinvested earnings, from 1982 to 2010 to get the stock of FDI. We can then obtain the ratio through the formula $\frac{(2)+(3)}{(1)+(2)+(3)}$.

⁴⁵In particular, the sum of intercompany debt (item **(2)**) from 1982 to 2010 is about \$148,128 million, the reinvested earnings (item **(3)**) is about \$1,979,725 million, and the equity investment (item **(1)**) is \$1,264,370 million. If we look at the net FDI outflow from U.S. to all countries, item (2) is -\$323,179 million, item (3) is \$1,753,657 million, and item (1) is -\$1,205,846 million. Therefore, in terms of absolute level, (2)+(3) still dominate (1).

⁴⁶Category "Others" contains foreign sharing-holding enterprises (SH) and joint exploration (JE).

represent new businesses established and owned by foreign firms. The following figure reports the shares of WFOs and EJV+CJV in total FDI inflows to China. As can be seen, after China's accession to WTO in 2001, WFOs exceed EJV+CJV and become the dominant form of FDI inflows. Therefore, we can safely infer that new businesses set up by foreign firms play a dominant role in FDI inflows.