

EUROPEAN ECONOMY

Economic Papers 430 | December 2010



China's External Surplus: Simulations with a Global Macroeconomic Model

Lukas Vogel

Economic Papers are written by the Staff of the Directorate-General for Economic and Financial Affairs, or by experts working in association with them. The Papers are intended to increase awareness of the technical work being done by staff and to seek comments and suggestions for further analysis. The views expressed are the author's alone and do not necessarily correspond to those of the European Commission. Comments and enquiries should be addressed to:

European Commission
Directorate-General for Economic and Financial Affairs
Publications
B-1049 Brussels
Belgium
E-mail: Ecfinfo@ec.europa.eu

This paper exists in English only and can be downloaded from the website
ec.europa.eu/economy_finance/publications

A great deal of additional information is available on the Internet. It can be accessed through the Europa server (ec.europa.eu)

KC-AI-10-430-EN-N

ISSN 1725-3187
ISBN 978-92-79-14916-0
doi 10.2765/445822

© European Union, 2010
Reproduction is authorised provided the source is acknowledged.

China's External Surplus: Simulations with a Global Macroeconomic Model

Lukas Vogel*

DG Economic and Financial Affairs

European Commission

Abstract:

The paper analyses China's external position in a multi-region macroeconomic model of the world economy. The model includes a portfolio structure and Forex intervention to proxy net/gross and government/non-government foreign asset positions, capital controls and exchange rate management in China. The selected set of transition and globalisation shocks replicates China's external position well, suggesting that it reflects capital exports driven by shifts in domestic saving supply, rather than shifts in foreign saving demand. The simulations also highlight the importance of effective capital controls for the viability of China's exchange rate management. Finally, the analysis suggests that enhanced flexibility of the RMB exchange rate could reduce China's net creditor position.

JEL classification: F30, F40

Keywords: China, Forex intervention, capital controls, external position

* I thank Yin-Wong Cheung, Jakob de Haan, Guonan Ma, Robert McCauley, Ulrich Jochheim, Heikki Oksanen, James Reade, Werner Roeger, Andreas Steiner, István Székely, Jan in't Veld and participants of the CESifo Summer Institute 2010 for valuable comments and suggestions. The views in the paper are those of the author and should not be attributed to the European Commission. Contact details: Lukas Vogel, DG ECFIN, European Commission, BU-1 3/129, B-1049 Brussels, Belgium; email: lukas.vogel@ec.europa.eu.

1. INTRODUCTION

The Chinese economy has transformed and developed remarkably during the past 20 years. Real output has grown at annualised two-digit rates. Per capita income has risen from 5 to 20 percent of EU-15 levels. At the same time China has accumulated large external surpluses and has become the world's largest international creditor.

The paper focuses on the link between China's economic transition and integration, on the one side, and its position as large net capital exporter, on the other side. Contrary to the Chinese experience, the textbook open-economy model would suggest economic catch-up to coincide with net capital imports and a (transitory) international debtor position.

The paper uses a multi-country version of the QUEST III macroeconomic model (Ratto et al., 2009). The four model regions are China, the United States, the euro area and the rest of the world. I extend the standard QUEST structure by introducing (1) a portfolio approach that distinguishes gross/net and government/non-government sector foreign asset positions and accounts for limited cross-border capital mobility, and (2) exchange rate management in the form of sterilised foreign exchange (Forex) intervention. The two extensions represent key elements of macroeconomic policy in China, namely the imposition of capital controls and exchange rate management. The rest of the model is fairly standard in that it includes only distortions/frictions in the China block that are standard also in the euro area and US settings.

The paper relates to previous research on global imbalances, especially from the angle of capital exporting countries, within multi-region DSGE models of the world economy, such as Cova et al. (2009), Faruqee et al. (2007), and Straub and Thimann (2009). These contributions do not include capital controls and Forex intervention in their models, however. The standard fix of augmenting the interest rate rule by exchange rate targets precludes a differentiated perspective on government versus private foreign asset positions and sterilised Forex intervention. Furthermore, the present paper puts more effort into a China-typical calibration of model parameters and exogenous shocks than previous DSGE-based analyses.

The paper selects a set of shocks that cover important aspects of China's economic transition and integration in the world economy, namely TFP catch-up, labour supply growth, labour reallocation, precautionary saving and export growth, and investigates their ability to match key stylised facts, namely the accumulation of net foreign assets (NFA) that combines increasing Forex reserves of the central bank with a net debtor position of the non-government sector, persistent surpluses in the trade balance and the current account, high real output growth, and declining (increasing) domestic demand shares of consumption (investment).

The simulations show that the set of shocks replicates China's external position quite well in the benchmark setting with limited capital mobility and Forex intervention, though the fit is less satisfactory for domestic demand shares. The results also highlight that effective capital controls, i.e. binding restrictions on cross-border capital flows, are crucial for the viability of China's exchange rate management. Finally, the simulations suggest that enhanced flexibility of the RMB exchange rate would lead to RMB appreciation under the selected set of shocks, reduce China's NFA position and contribute to changing the composition of China's growth from exports towards domestic demand. Robustness checks indicate that a potential asymme-

try of capital controls and alternative values for the elasticity of labour supply have little bearing on the results, while assumptions on expectation formation (perfect foresight versus simple extrapolation) are crucial.

The structure of the paper is as follows. Section 2 provides a short review of the literature to place my analysis in context. Section 3 presents stylised facts on China's economic development that model simulations should replicate. Section 4 introduces the portfolio approach and Forex intervention into QUEST. Section 5 details the calibration of the model parameters. Section 6 presents the simulation scenarios, results for alternative policy regimes and robustness checks. Section 7 summarises the findings and concludes.

2. REVIEW OF THE LITERATURE

The emergence and persistence of large current account imbalances have generated many policy statements and a large body of economic research (Gruber and Kamin, 2007). Part of it focuses on net debtor countries as the demand side (e.g., Bems et al., 2007; Blanchard, 2007; Bussiere et al., 2005; Chinn and Prasad, 2003; Chinn and Ito, 2008; Corsetti and Mueller, 2006), part deals with net creditors as the suppliers of savings (e.g., Blanchard and Giavazzi, 2005; Bracke and Fidora, 2008; Cova et al., 2009; Lee and McKibbin, 2006; Mendoza et al., 2007; Yu, 2007). Multi-country model simulations (e.g., Choi et al., 2008; Choi and Mark, 2009; Faruquee et al., 2007; N'Diaye et al., 2010) often combine both sides.

China's large NFA and current account surpluses reflect a persistent excess of domestic savings over domestic investment. The external surplus is difficult to reconcile with the neoclassical textbook model, given the country's position as emerging economy with TFP catch-up and growing labour supply. According to the standard model, TFP and labour supply growth increase the marginal productivity of capital and should lead to net capital inflows (e.g., Dollar and Kraay, 2006; Ma and Haiwen, 2009; Straub and Thimann, 2009).

Economists have proposed several (not mutually exclusive) solutions to this paradox. A first group (e.g., Blanchard and Giavazzi, 2005; Blanchard, 2007; Chamon and Prasad, 2010; Feng et al., 2009; Ma and Haiwen, 2009; Modigliani and Cao, 2004; Wei and Zhang, 2009; Wen, 2009) sees precaution, due to population ageing, the decline of traditional families as old-age support, weak social security systems or even unbalanced gender ratios, as root cause for excess savings in the private sector. Choi and Mark (2009) and Choi et al. (2008) use state-dependent heterogeneity in discount rates to implement state-dependent saving and cross-country savings differentials in DSGE models. Patient economies lend to foreigners, impatient economies borrow from abroad. Gertler (1999) and Roeger (2003) generate cross-country heterogeneity in saving rates in models with demographic change. Faruquee et al. (2007) impose regional differences in the calibration of the discount factor to generate a steady state with external imbalances. Straub and Thimann (2009) show that weak responses of domestic demand to permanent income shifts are able to generate positive correlation between output growth and the trade balance in reaction to technology and labour supply growth. The time-varying cost of money holding and the time-varying consumption tax that the authors use to proxy frictions in domestic demand adjustment are empirically not very intuitive, however.

A second group focuses on policies to promote exports and limit financial vulnerability as potential explanation. Exchange rate management and capital controls have received particular attention in this context. Exchange rate management has been labelled as protectionist measure to promote trade competitiveness and export growth (e.g., Dooley et al., 2007; Faruqee et al., 2007). Foreign reserve accumulation also provides the government with a war chest to defend its currency against speculative attacks (e.g., Cova et al., 2009; Prasad and Rajan, 2008).

RMB undervaluation and the impact on external balances remain disputed. The meta-analysis by Korhonen and Ritola (2009) illustrates that most empirical studies (e.g., Cline and Williamson, 2009) find the RMB (heavily) undervalued, but Cheung et al. (2007a, 2007b) object that the evidence in those studies is no basis for strong verdicts. External balances depend ultimately on real effective exchange rates (REER), also affected by relative price and wage dynamics. Chinn and Wei (2009) find no strong, robust and monotonic link between nominal exchange rate flexibility and REER adjustment. Dooley et al. (2007), McKinnon (2006, 2007), McKinnon and Schnabl (2009), and Xiao (2008) stress that real appreciation is compatible with flexible and fixed nominal rates, provided that wage and price levels can adjust.

A third group explains saving-investment imbalances as the result of frictions/heterogeneity in financial markets. Caballero et al. (2008) argue that imbalances can be the equilibrium in a world in which regions differ in their capacity to generate financial assets for real investment. Mendoza et al. (2007) consider the impact of financial market development on saving and asset demand. Both papers focus on the US external deficit, but do not explain why notably China has become a large international creditor. Real investment in China is high by international standards and has grown during the period of NFA accumulation, which lends limited plausibility to the hypothesis that lacking investment opportunities are the root cause for its net capital export.

Song et al. (2009) analyse financial frictions in the form of limited access to credit. Their model features high-productivity private firms that have poor access to capital markets, so that they must finance investment out of internal savings, and low-productivity state enterprises that have much better access to credit. The rising share of private firms implies that domestic saving for future investment is increasing and held in foreign assets. The model does not include the government's role as owner of foreign reserves, however, which dominates China's NFA surplus. Recent empirical evidence in Bayoumi et al. (2010) that rejects the hypothesis of significant differences in the savings behaviour of private versus state-owned Chinese firms and the hypothesis of significant differences between the savings behaviour of Chinese companies and the global average also challenges the model.

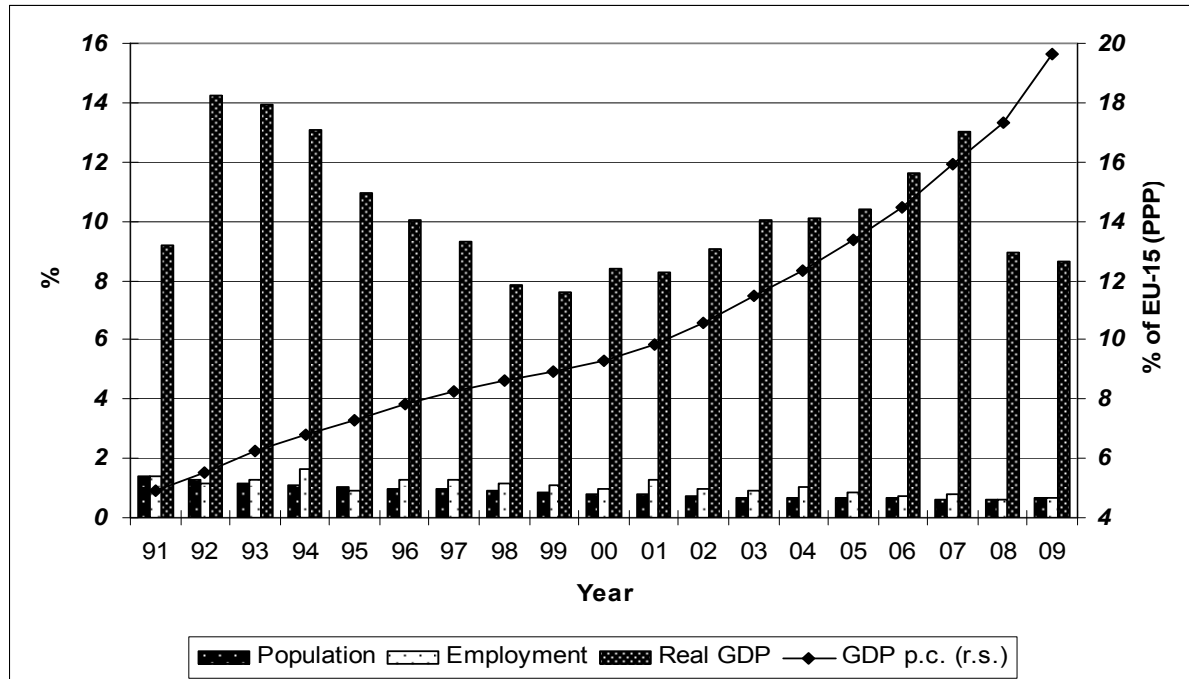
The present paper combines elements of the first and second group. I consider economic transition/international integration together with capital controls and Forex intervention to investigate whether they can jointly replicate the pattern of China's NFA accumulation.

3. STYLISED FACTS

The Chinese economy has developed rapidly during the last decades, with real output growth of around 10 percent per year and a steady convergence in per capita income towards industrialised countries (Figure 3.1).

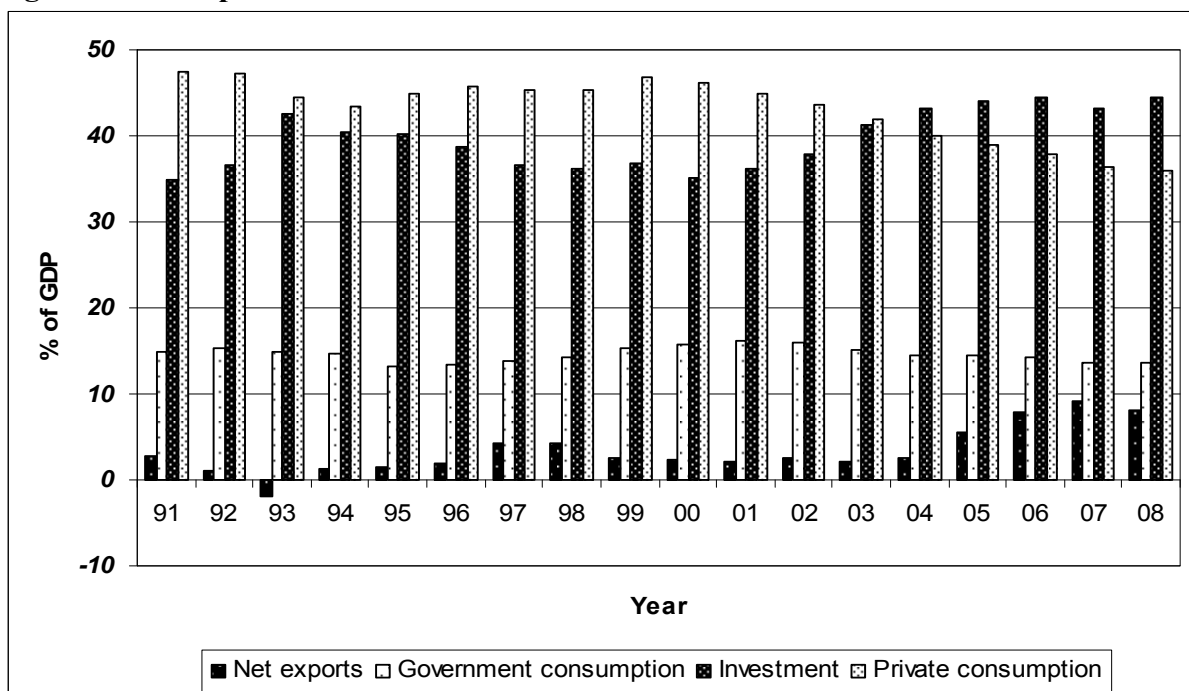
The moderate employment growth during the same period highlights the role of capital deepening and TFP growth in this process. The strength of investment in total demand also illustrates the importance of capital deepening. The output share of investment demand has increased, whereas the share of private consumption has fallen. The relative size of government consumption has remained fairly stable, and net exports have increased (Figure 3.2).

Figure 3.1: Output and per capita income growth



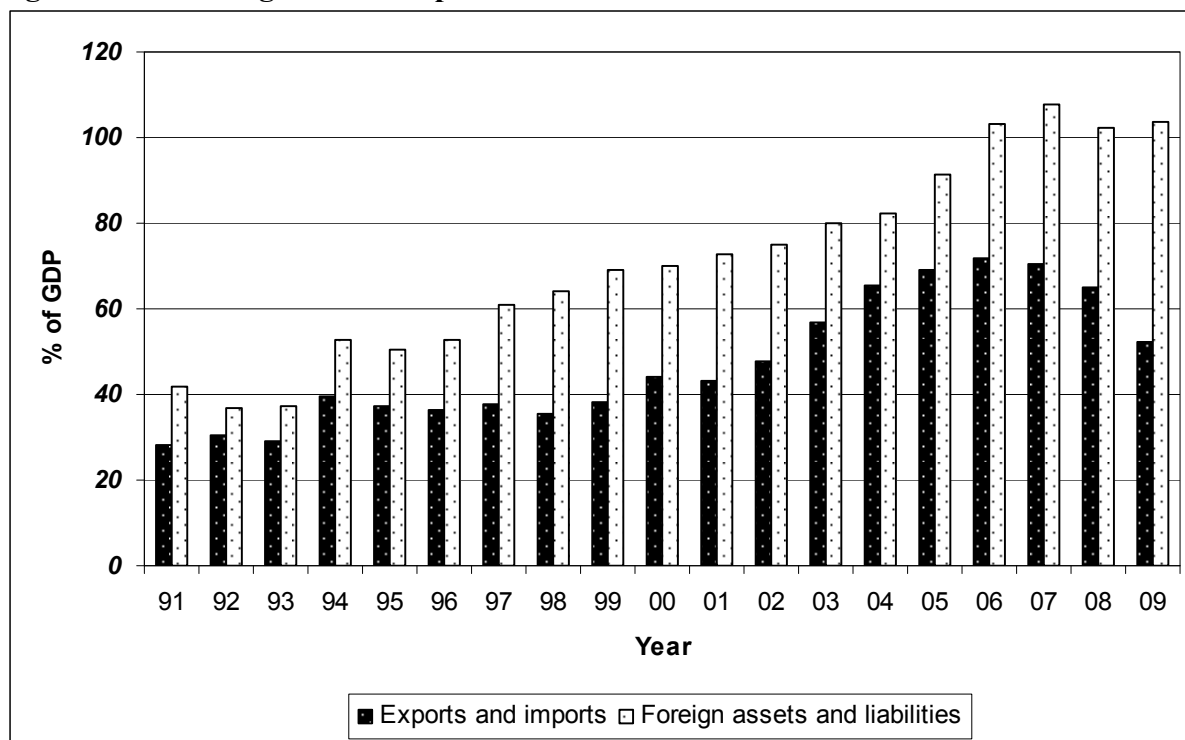
Sources: ECFIN AMECO, IMF IFS

Figure 3.2: Composition of final demand



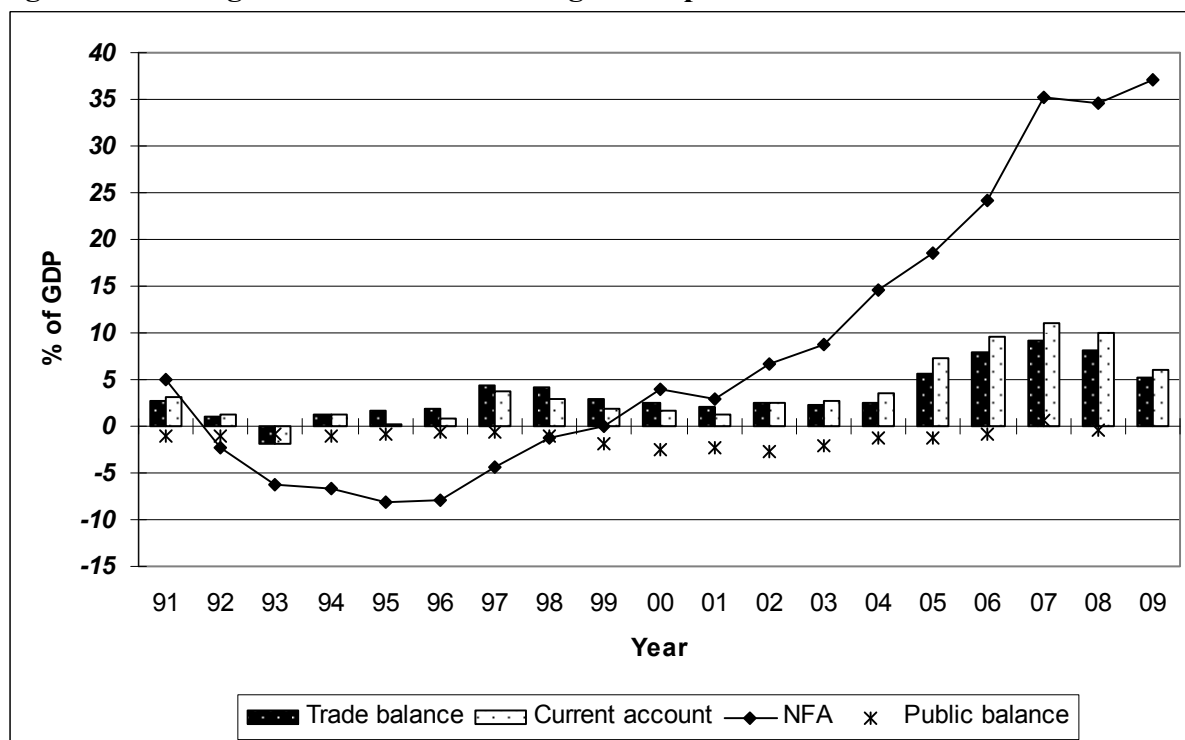
Source: IMF IFS

Figure 3.3: Growing economic openness



Sources: ECFIN AMECO, IMF IFS, Lane and Milesi-Ferretti (2007)

Figure 3.4: Foreign balances and net foreign asset position



Sources: China Statistical Yearbook, IMF IFS, Lane and Milesi-Ferretti (2007)

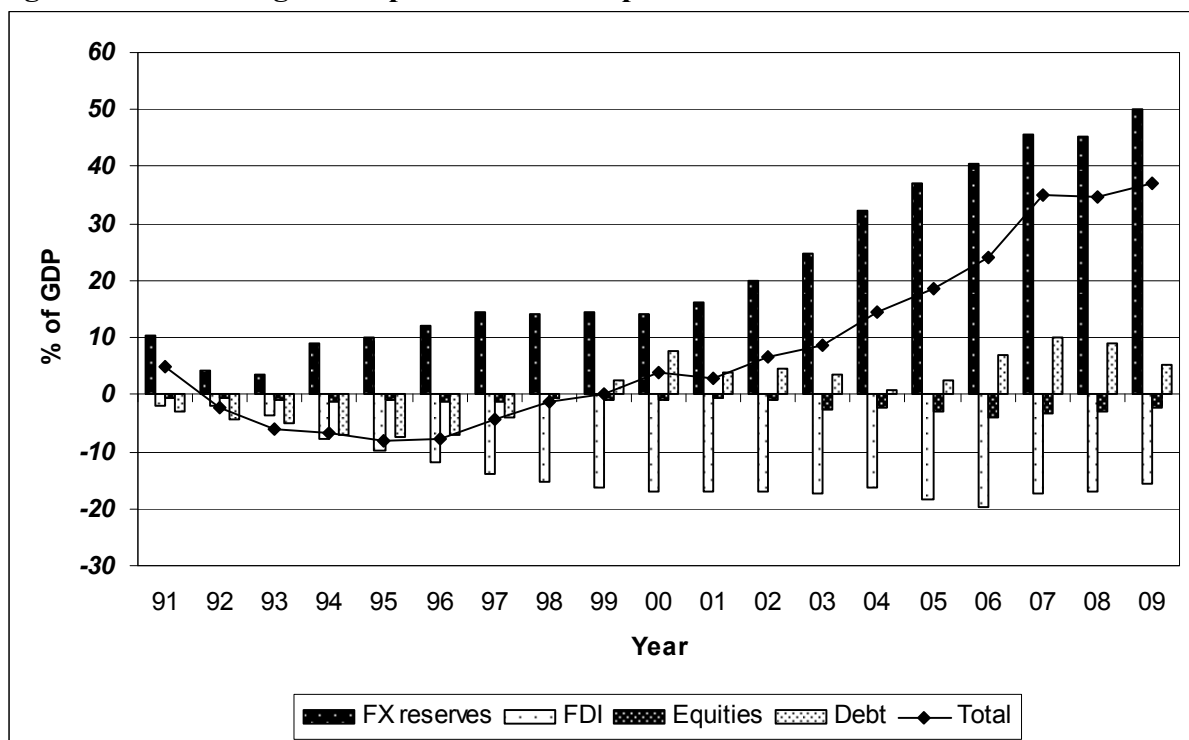
China's economic transition and convergence coincides with the country's increasing integration in international goods and capital markets. Total trade as the sum of exports and imports

and gross asset positions as the sum of foreign assets and liabilities have risen relative to GDP (Figure 3.3).

Despite strong investment, strong output growth and increasing integration in global markets, China has constantly run trade and current account surpluses since the mid-1990s. Its NFA position has increased accordingly. The government budget has been balanced or in small deficit during those years, implying that excess saving has come from households and/or firms (Figure 3.4).

The large positive NFA position combines even larger Forex reserves of the central bank and a negative net position of the non-government (including state-owned companies) sector (Figure 3.5). China is typical at least for the net inflow of FDI, which is standard in emerging economies. China has tilted capital inflows towards FDI; portfolio investment has been less important so far (Prasad and Wei, 2005; Prasad and Rajan, 2008).

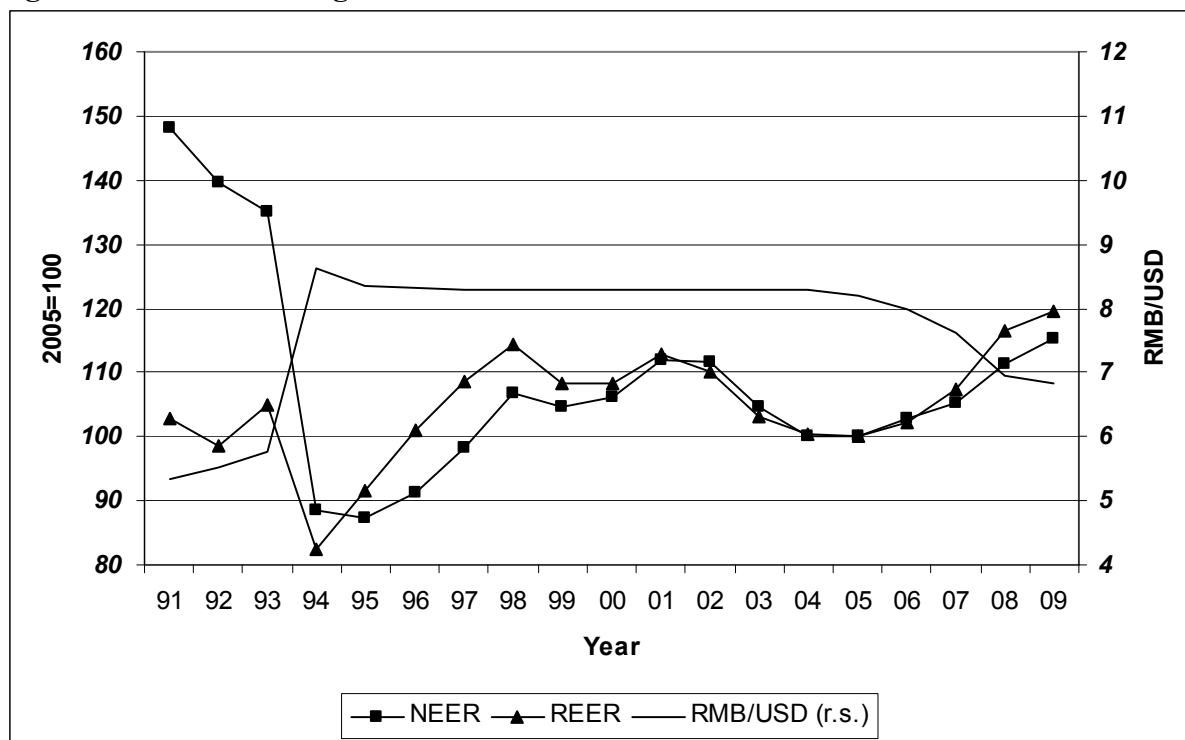
Figure 3.5: Net foreign asset position and components



Sources: IMF IFS for years 04-09; Lane and Milesi-Ferretti (2007) for years 91-03

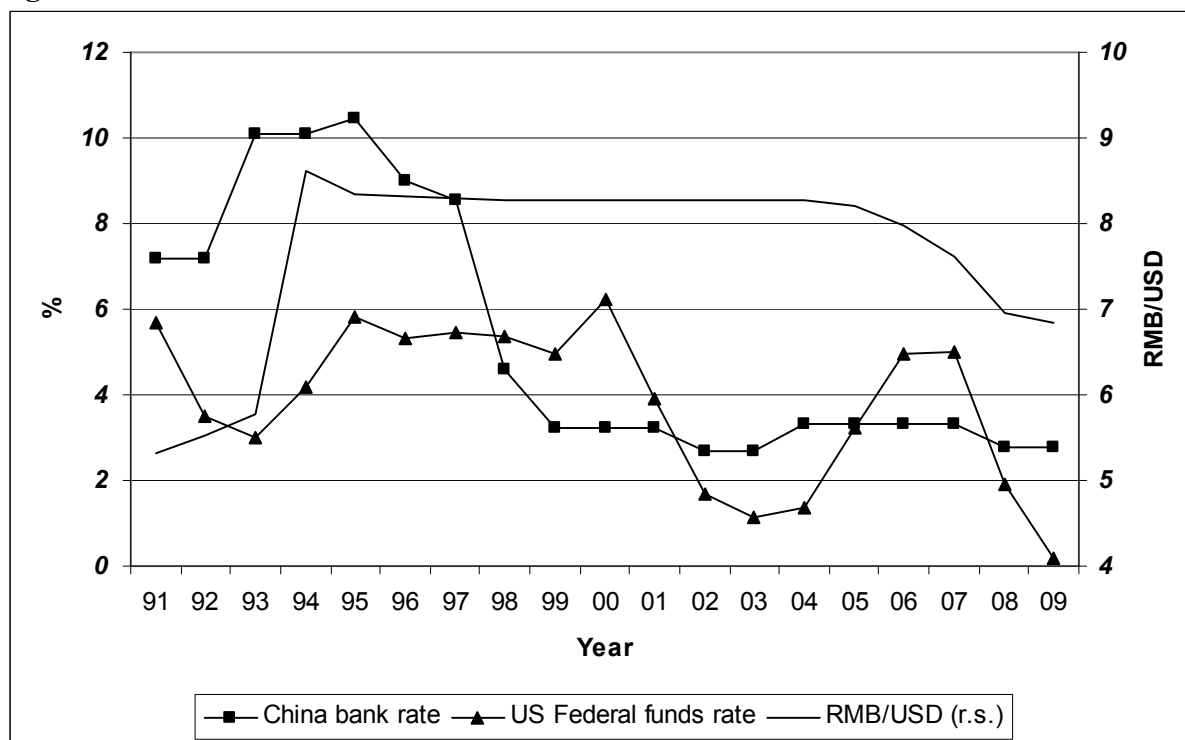
The restrictions on cross-border capital flows have diminished in recent years. Currency inconvertibility ended in 1994, when the Chinese authorities abolished exchange rate controls on current account transactions, i.e. trade, interest and dividend payments, and unified the exchange rate from a system in which multiple rates coexisted in fragmented markets (McKinnon and Schnabl, 2009). The decision in 1994 to peg the RMB to the USD (Figure 3.6) has forced the Chinese central bank (PBC) into large Forex operations and the accumulation of large Forex reserves in the context growing capital mobility and pressure towards RMB appreciation. The PBC has sterilised the impact of Forex interventions on domestic money supply by offsetting sales/purchases of domestic bonds in line with domestic inflation and output targets (e.g., Glick and Hutchinson, 2008; Ouyang et al., 2008).

Figure 3.6: RMB exchange rates



Source: IMF IFS

Figure 3.7: Short-term interest rate differential



Source: IMF IFS

Nevertheless, continuing restrictions on the capital account remain effectively binding. Figure 3.7 shows China-US short-term interest rate differentials in a period of RMB-USD exchange

rate stability. The deviation from uncovered interest rate parity (UIP) provides an indication that barriers to capital mobility have remained effective after 1994.¹

Ma and McCauley (2008) offer a more detailed and sophisticated analysis of the effectiveness of capital controls. They find deviations from UIP by 100 basis points and more in 1997-2005 and large, persistent yield differentials for identical assets in onshore versus offshore markets, indicating significant limitations to cross-border arbitrage.

4. MODELLING CAPITAL CONTROLS AND FOREX INTERVENTION

The analysis uses the QUEST macroeconomic model.² The model regions are populated by representative households and firms and have monetary and fiscal authorities committed to rules-based stabilisation policies. Each region has tradable and non-tradable goods sectors. Tradable goods produced in one region are imperfect substitutes for goods produced in other regions.

The model includes two types of households: (1) liquidity-constrained households that, in each period, consume the disposable wage and transfer income, and (2) finitely-lived but forward-looking households that have full access to financial markets and make optimal intertemporal choices. The optimising households decide on financial and real capital investment and allocate wealth over domestic and foreign assets. Figure 4.1 summarises the basic structure of the QUEST model.

I depart from the standard assumption of perfect international capital mobility and introduce imperfect substitutability between domestic and foreign assets to proxy legal and factual restrictions on cross-border capital flows. The portfolio decision is modelled as in Blanchard et al. (2005) and Breuss et al. (2009). In the model it applies to the China block and the decision between RMB and USD asset investment.

The second extension to QUEST is the modelling of Forex intervention as the PBC's instrument for exchange rate management. Forex intervention affects the domestic money supply and is sterilised in line with domestic objectives, notably low inflation and output stability.

The portfolio approach replaces the assumption of perfect substitutability between domestic and foreign assets of identical risk that gives rise to the standard UIP condition. Limited substitutability reduces the responsiveness of capital flows to cross-border return differentials and provides scope for Forex intervention to stabilise the exchange rate.

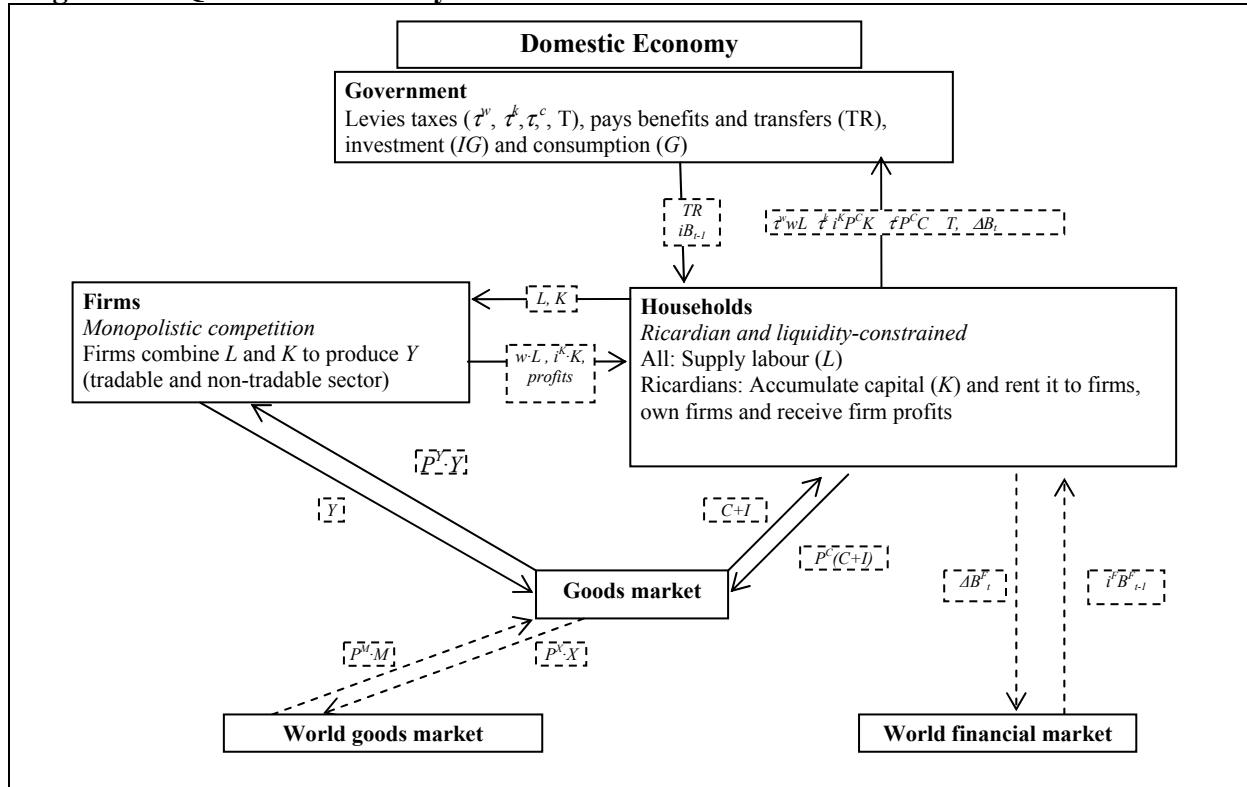
This chapter describes the portfolio approach and the modelling of Forex intervention in a two-country framework with domestic and foreign economies indexed d and f . Within the four-region model and given the focus on the RMB-USD portfolio decision and RMB-USD exchange rate stabilisation, China becomes the domestic economy and the United States the foreign counterpart.

1 This statement requires some qualification. Perfect capital mobility implies interest rate convergence if, and only if, the RMB-USD peg is credible and differentials in country risk premia narrow or disappear over time.

2 See Ratto et al. (2009) for a detailed description of QUEST III.

The modelling of goods and labour demand and supply corresponds to the standard QUEST specification. The equations for consumption, employment, productive investment and international trade remain therefore unchanged.

Figure 4.1: QUEST III country block



4.1 Household portfolio decision

Domestic and foreign households diversify portfolios across borders and both hold shares of domestic and foreign capital stocks. Part of the total value of domestic firms (V^d) is in domestic ownership (V^{dd}), the other part in foreign ownership (V^{df}). The same applies to shares of foreign firms (V^f):

$$(1) \quad V_t^d = V_t^{dd} + V_t^{df}$$

$$(2) \quad V_t^f = V_t^{ff} + V_t^{fd}$$

The values are expressed in real terms as measured in the country in which the firms are located.

For a given expected yield differentials, the domestic demand for domestic/foreign assets depends on the home bias (b^d) of investors, the elasticity of portfolio decisions with respect to yield differentials (σ^d) and domestic household wealth (F^d):

$$(3) \quad V_t^{dd} = \left[b^d + \sigma^d \left(r_t^d - r_t^f - E_t \frac{\Delta e_{t+1}}{e_t} \right) \right] \left(F_t^d - \frac{B_t^{dd}}{P_t^d} \right)$$

$$(4) \quad e_t \frac{P_t^f}{P_t^d} V_t^{fd} = \left[(1-b^d) - \sigma^d \left(r_t^d - r_t^f - E_t \frac{\Delta e_{t+1}}{e_t} \right) \right] \left(F_t^d - \frac{B_t^{dd}}{P_t^d} \right)$$

The portfolio decision of foreign households is analogous:

$$(5) \quad V_t^{ff} = \left[b^f - \sigma^f \left(r_t^d - r_t^f - E_t \frac{\Delta e_{t+1}}{e_t} \right) \right] \left(F_t^f - \frac{B_t^{ff}}{P_t^f} \right)$$

$$(6) \quad \frac{1}{e_t} \frac{P_t^d}{P_t^f} V_t^{df} = \left[(1-b^f) + \sigma^f \left(r_t^d - r_t^f - E_t \frac{\Delta e_{t+1}}{e_t} \right) \right] \left(F_t^f - \frac{B_t^{ff}}{P_t^f} \right)$$

Capital controls can translate into strong home bias (b), i.e. little steady-state portfolio diversification, and/or a low substitution elasticity (σ), i.e. little adjustment to expected yield differentials.

Real household wealth is the sum of government bond (B) and productive asset (V) holdings. I assume for simplicity that private investors hold only government debt of their respective country ($B^{fd}=0, B^{df}=0$):

$$(7) \quad F_t^d = \frac{B_t^{dd}}{P_t^d} + V_t^{dd} + e_t \frac{P_t^f}{P_t^d} V_t^{fd}$$

$$(8) \quad F_t^f = \frac{B_t^{ff}}{P_t^f} + V_t^{ff} + \frac{1}{e_t} \frac{P_t^d}{P_t^f} V_t^{df}$$

In equilibrium, the relative supply of domestic/foreign assets must equal the relative demand for domestic/foreign assets (see Blanchard et al., 2005; Breuss et al., 2009):

$$(9) \quad V_t^d - e_t \frac{P_t^f}{P_t^d} V_t^f = V_t^{dd} + V_t^{df} - e_t \frac{P_t^f}{P_t^d} V_t^{ff} - e_t \frac{P_t^f}{P_t^d} V_t^{fd}$$

Combining this equilibrium condition with the demand functions (3) to (6) establishes a link between the expected yield differential and the aggregate asset allocation:

$$(10) \quad \frac{r_t^d - r_t^f - E_t \frac{\Delta e_{t+1}}{e_t}}{1} = \frac{V_t^d - e_t \frac{P_t^f}{P_t^d} V_t^f + (1-2b^d) \left(F_t^d - \frac{B_t^{dd}}{P_t^d} \right) - (1-2b^f) e_t \frac{P_t^f}{P_t^d} \left(F_t^f - \frac{B_t^{ff}}{P_t^f} \right)}{2 \left[\sigma^d \left(F_t^d - \frac{B_t^{dd}}{P_t^d} \right) + \sigma^f e_t \frac{P_t^f}{P_t^d} \left(F_t^f - \frac{B_t^{ff}}{P_t^f} \right) \right]}$$

Equation (10) can be seen as generalised interest parity condition and has important policy implications. Low values of the elasticity of substitution (σ) limit the impact of interest rate differentials on exchange rate adjustment, so that capital controls that are effective in restrict-

ing yield arbitrage allow the coexistence of exchange rate targeting and monetary policy independence.

4.2 Forex intervention

Current government debt (B) is the sum of past debt, debt service and the primary deficit as the difference between government consumption (G), investment (IG), transfers and subsidies (TR), on the one side, and tax revenues (T) plus central bank profit, on the other side:

$$(11) \quad B_t^d = (1 + r_{t-1}^d) B_{t-1}^d + P_t^{cd} (G_t^d + IG_t^d) + TR_t^d - T_t^d - profit_t^{CBd}$$

Government debt is entirely held by domestic residents and domestic/foreign central banks:

$$(12) \quad B_t^d = B_t^{dd} + B_t^{dCBd} + B_t^{dCBf}$$

$$(13) \quad B_t^f = B_t^{ff} + B_t^{fCBf} + B_t^{fCBd}$$

Defining China as the domestic economy, I simplify further and set foreign central bank holdings of domestic government debt to zero ($B_t^{dCBf}=0$).

Changes in the stock of outstanding money must be backed on the central bank's balance sheet by domestic or foreign bonds:

$$(14) \quad B_t^{dCBd} + e_t B_t^{fCBd} = \Delta M_t$$

Central bank profit is the net return on the central bank's asset portfolio:

$$(15) \quad profit_t^{CBd} = r_{t-1}^d B_{t-1}^{dCBd} + r_{t-1}^f e_t B_{t-1}^{fCBd}$$

As specified in the budget constraint (11), the central bank transfers the profit to the government budget.

Policy objectives determine the portfolio of the central bank in a two-stage process. In the first step, Forex interventions are implemented to stabilise the exchange rate at the target level (γ_e) or the status quo ($\gamma_{\Delta e}$):

$$(16) \quad B_t^{fCBd} = B_{t-1}^{fCBd} - \gamma_e (e_t / \bar{e} - 1) - \gamma_{\Delta e} (e_t / e_{t-1} - 1)$$

The Forex interventions determine the central bank's foreign reserve position.

In the second step, the central bank sterilises the effect of Forex interventions on domestic money supply. It sells/purchases domestic bonds to keep domestic interest rates at levels compatible with inflation and output targets:

$$(17) \quad r_t^d = (1 - \rho)(\bar{r} + \bar{\pi}) + \rho r_{t-1}^d + (1 - \rho) \gamma_\pi (\pi_t^{cd} - \bar{\pi}) + (1 - \rho) \gamma_y (y_t^d - \bar{y})$$

The interest rate from rule (17) and the balance sheet identity (14) jointly determine the domestic money supply and the net holding of domestic currency bonds by the central bank.³

Accounting for limited capital mobility and Forex intervention departs from the modelling in Faruqee et al. (2007), N'Diaye et al. (2010), and Straub and Thimann (2009), where capital markets are fully integrated and exchange rate targets included in the central bank's interest rate rule. The two-stage modelling of exchange rate and monetary policy approximates the practice of sterilised Forex intervention (Obstfeld and Rogoff, 1996). Explicit modelling of the balance sheet (14) is also necessary to account for the crucial role of Forex reserves in China's NFA portfolio.

4.3 NFA position

The NFA position in real terms is the difference between foreign assets in domestic ownership and domestic assets in foreign ownership:

$$(18) \quad BWR_t^d = e_t \frac{B_t^{fCBd}}{P_t^d} + e_t \frac{P_t^f}{P_t^d} V_t^{fd} - V_t^{df}$$

$$(19) \quad BWR_t^f = -\frac{1}{e_t} \frac{P_t^d}{P_t^f} BWR_t^d$$

The NFA position (18) combines the foreign asset positions of the central bank and the non-government sector, while the NFA position of the foreign country is the mirror image of the domestic economy's NFA position.

The NFA position evolves over time as a function of the past NFA position, the net interest income and the trade balance:

$$(20) \quad BWR_t^d = (1 + r_{t-1}^f) e_t \left(\frac{B_{t-1}^{fCBd}}{P_t^d} + \frac{P_t^f}{P_t^d} \frac{P_{t-1}^f}{P_t^f} V_{t-1}^{fd} \right) - (1 + r_{t-1}^d) \frac{P_{t-1}^d}{P_t^d} V_{t-1}^{df} + \frac{P_t^{xd}}{P_t^d} X_t^d - \frac{P_t^{md}}{P_t^d} IM_t^d$$

Net interest inflows and trade surpluses increase the NFA position; net interest outflows and trade deficits reduce the NFA position.

5. MODEL CALIBRATION

The simulations use an annualised version of QUEST with four model regions, namely China, the United States, the euro area and the rest of the world (RoW). Table 5.1 summarises the calibration of the model parameters for the different regions. The regions' economic size, trade openness, bilateral trade linkages and sector structure (tradable, non-tradable) come from the

³ Money supply rules could be used instead of the interest rate rule as an alternative mechanism to relate domestic monetary conditions to stabilisation objectives. Money supply rules that lead to the same interest rate level as rule (17) imply identical monetary conditions.

GTAP 2004 database. The calibration of the US and euro area blocks draws on estimated US and euro area models presented in Ratto et al. (2009, 2010).

Table 5.1: Calibration of the global model

Parameter	China	U.S.	Euro area	RoW
Domestic ownership share of domestic capital (b)	0.93	0.99	-	-
Elasticity of portfolio decisions (σ)	0.60	0.60	-	-
Taylor rule interest rate persistence (ρ)	0.45	0.45	0.45	0.45
Taylor rule coefficient on CPI inflation (γ_π)	1.15	1.50	1.50	1.50
Taylor rule coefficient on output gap (γ_v)	0.51	0.05	0.05	0.05
Share of liquidity-constrained consumers	0.70	0.40	0.40	0.40
Habit persistence	0.24	0.24	0.24	0.24
Household planning horizon (years)	30.0	30.0	30.0	30.0
Inverse of elasticity of labour supply	5.00	3.00	5.00	5.00
Size of tradable sector (2004, output share)	0.46	0.22	0.32	0.28
Steady-state trade openness (2004, exports to GDP)	0.42	0.14	0.18	0.18
Price elasticity of exports and imports	1.50	1.50	1.50	1.50
Share in world output (2004, nominal USD)	0.05	0.29	0.23	0.44
Capital adjustment cost	15.0	6.25	7.50	7.50
Investment adjustment cost	10.0	2.50	3.75	3.75
Labour adjustment cost	6.25	5.00	6.25	6.25
Price adjustment cost for tradable goods	10.0	5.00	6.25	6.25
Price adjustment cost for non-tradable goods	15.0	10.0	10.0	10.0
Exports goods price adjustment cost	0.00	0.00	0.00	0.00
Nominal wage adjustment cost	7.50	3.75	7.50	7.50
Degree of forward-looking in domestic pricing	0.90	0.90	0.90	0.90
Degree of forward-looking in export pricing	0.80	0.80	0.80	0.80
Degree of forward-looking in wage setting	0.90	0.90	0.90	0.90

Although the RoW is a heterogeneous set of economies, including the rest of Asian, European countries outside the euro area, OPEC members, Latin America and Australia, euro area values are used to calibrate this block. The simplification parallels the practice in, e.g., Cova et al. (2009), Faruquee et al. (2007), N'Diaye et al. (2010), and Straub and Thimann (2009), which apply identical values for many of the behavioural parameters and frictions to all model regions.

As the limited availability of empirical evidence and estimates also complicates the calibration of the China block, I limit deviations from the US/euro area calibration to the portfolio composition, the trade linkages, the sector structure and those parameters for which I could find supportive evidence.

The simulations start from a baseline with balanced trade and NFA positions and investigate the reaction of external balances to transition/integration shocks and policy settings. For simulations starting in the mid-1990s, the balanced baseline seems an admissible approximation.

Calibrating the portfolio structure requires an estimate for cross-border asset positions. I use the Lane and Milesi-Ferretti (2007) data on foreign asset positions in the early 1990s as starting point. Gross foreign asset holdings of China's non-government sector equal 13 percent of GDP and Forex reserves 7 percent of GDP in the baseline. The numbers imply that Chinese households and firms initially hold 97 percent of the Chinese capital stock and 1 percent of worldwide USD assets.⁴

The efficiency of capital controls has arguably weakened over time, but the restrictions are still binding (Ma and McCauley, 2008; Prasad, 2009a), implying a limited reaction of portfolio decision to expected yield differentials. Direct empirical evidence on the value of σ , the decisive parameter to pin down the real impact of portfolio choices, is at best scarce. Blanchard et al. (2005) and Breuss et al. (2009) use $\sigma=1$, implying that a 100 basis-point increase in the expected yield on foreign assets raises the desired foreign asset share in portfolios by one percentage point. Combining the estimates of RMB-USD yield differentials (1996-2006) by Cheung et al. (2008), and Ma and McCauley (2008) with equation (10) suggest $\sigma=0.6$, which I will use in the baseline calibration. This value gives plausible magnitudes of NFA positions under the set of exogenous shocks discussed in section 6. Potential asymmetry in the extent and timing of capital liberalisation notwithstanding, the baseline assumes that the elasticity for Chinese investment in USD equals the elasticity for foreign investment in RMB assets ($\sigma^d=\sigma^f$).

The central scenario assumes a constant RMB-USD peg over the entire simulation horizon, corresponding to a high value of γ_e . I will then compare the central scenario to scenarios with higher capital mobility and RMB floating ($\gamma_e=0$) to assess the impact of capital controls and Forex intervention on China's external position. Forex intervention targets the bilateral RMB-USD rate, not nominal or real effective exchange rates. Additional weight on exchange rate smoothing is excluded ($\gamma_{\Delta e}=0$).

The degree of sterilisation depends on domestic policy targets expressed in rule (17) with $\gamma_\pi=1.15$ and $\gamma_y=0.51$ and intrinsic persistence $\rho=0.45$, which corresponds to persistence of 0.82 at quarterly frequency. These values correspond to the Liu and Zhang (2007) estimate of a monetary policy rule for China (1990-2006) and put more weight on the output target than comparable estimates for the euro area and the US.

On the fiscal side, lump-sum taxes react to deviations of government debt from target and ensure public finance sustainability.⁵ The output shares of government consumption and investment are kept constant and public demand evolves in line with output as suggested by Figure 3.2. Government investment augments the productivity of private capital and labour. The model does not distinguish between private and state-owned enterprises. All firms are considered part of the private sector and all firm-level investment as private investment.

4 Given that capital exports to Hong Kong, Macau and Taiwan are partly redirected and reinvested, Li (2009) cautions against overestimation of mainland China's gross foreign asset position.

5 Using an alternative setting in which labour income taxes are adjusted to guarantee the sustainability of public debt has little impact on the results in section 6.

The China blocks in Faruqee et al. (2007), N'Diaye et al. (2010), and Straub and Thimann (2009) set the share of liquidity-constrained households higher than in the US and Europe. I follow this practice and use the Zhang and Wan (2004) estimate of 0.7 (1984-98) compared to 0.4 for the other regions, even though the empirical support for tighter constraints in China is not unchallenged (e.g., Modigliani and Cao, 2004). Given the lack of empirical evidence suggesting alternative values, consumer habit persistence is kept at 0.24 as for the other model regions and corresponds to 0.7 at quarterly basis. As in the other model regions, the planning horizon of intertemporal optimising households is set to 30 years.

The price elasticity of export/import demand is an important parameter in the context of external balances. Although one might expect the elasticity to be low on the import (commodities, investment goods) and high on the export side (low product differentiation), empirical estimates lend little support and are often sensitive to alternative data sources. Cheung et al. (2009) estimate Chinese imports to fall by 0.4-1.5 percent per percentage-point increase in import prices and exports to fall by less than one-to-one, or even to rise, when export prices increase (1993-2006). Estimates on US data for bilateral China-US trade suggest an elasticity of 1.0-1.3 for Chinese imports (insignificant with Chinese data) and 0.8-1.3 for exports (1.6-2.0 with Chinese data).⁶ Recent estimates by Ahmed (2009) find a price elasticity of Chinese exports of around 1.5 (1961-2009). In the light of this evidence, the calibration uses a price elasticity of 1.5 for Chinese trade as for the other world regions.⁷

The scarcity of comparable evidence on nominal and real rigidities leads Cova et al. (2009), Faruqee et al. (2007), N'Diaye et al. (2010), and Straub and Thimann (2009) to calibrate nominal and real product and factor market rigidities in China and emerging Asia as for the other world regions. This paper introduces some differentiation. Comparable evidence on product and factor market rigidities is certainly scarce and sketchy, but not non-existent. The OECD indicators of product market regulation (PMR) and employment protection legislation (EPL) provide, e.g., some indications (Herd et al., 2010; Woelfl et al., 2009).

Product markets in China seem still tightly regulated. The overall PMR score is 3.3, on a scale 0-6 where high values indicate strong regulation, compared to 0.8 in the US and 1.3 in the euro area. The sub-indicator "state involvement in business operations" has score 3.9 (0.9 in the US, 1.3 in the euro area) and "barriers to entrepreneurship" score 2.9 (1.2 in the US, 1.3 in the euro area). Price controls, command and control regulation, and the administrative burden on start-ups seem particularly pronounced. China's overall EPL score of 2.8 on the 0-6 scale is above the US (0.9) and close to the euro area values, although limited enforcement of labour laws and minimum wage requirements may increase de facto flexibility.

Based on China's relative position in the PMR and EPL rankings, I set the parameter values for price, investment and capital adjustment costs above and parameter values for wage and employment adjustment costs equal to the euro area calibration. As the concepts of PMR and EPL do not coincide with the concept of adjustment costs in QUEST, the choice is an informal guess.

6 Note that both pairs of import and export price elasticities fulfil the Marshall-Lerner condition, irrespective of the variation in the estimated point values between the two data sources. Compliance with the Marshall-Lerner condition implies that real appreciation has a negative impact on a country's trade balance.

7 Export and import price elasticities have possibly increased over time, especially in the context of China's WTO accession in 2001. The simulations do not consider parameter drift, however, but instead include growing world trade as a push to Chinese export demand.

The elasticity of labour supply is set to 1/3 in the US and 1/5 in China, the euro area and the RoW. The value for China, which may look surprisingly low given widespread priors on the flexibility of Chinese workers, corresponds to the firm-level estimates (1984-90) by Fleisher and Wang (2004).

Regarding inflation and output persistence, Mehrotra et al. (2007) estimate New Keynesian Phillips curves for China that indicate roughly equal weight for lags and leads of inflation. Liu and Zhang (2007) find lagged output and inflation to dominate the output and inflation equations of a small estimated model of the Chinese economy. These reduced-form estimates are not very informative for calibration, however. Inflation and output persistence may capture inertia in shocks and other variables rather than backward looking expectations. Many reduced-form estimates for the US and Europe find similar weights on lagged inflation and output. Given the persistence embodied in adjustment costs and the lack of further evidence, the degree of forward-looking is kept at the level of the other regions.

6. SIMULATIONS

Simulations with the global model illustrate the impact of exogenous shocks and economic policies (capital controls, Forex intervention) on China's external position and allow comparison with the stylised facts of section 3. I focus on a set of shocks with major impact on China's economic transition that may explain the country's external position. The domestic/transition and foreign/globalisation shocks are:

- TFP growth: Bosworth and Collins (2008) estimate an annualised TFP growth rate of 3.9 (3.6) percent in the period 1993-2004 (1978-2004). Li (2009) finds a similar annual rate of 4.3 percent for the period 1984-2006. I use the Bosworth and Collins (2008) estimate of 3.9 percent and decompose it into 2.4 percent TFP convergence towards the leading countries and the 1.5 percent world trend TFP growth that is incorporated in the model. TFP convergence is tilted towards the tradable sector, where 3/4 of the TFP convergence occurs, as opposed to the non-tradable sector, which contributes 1/4.⁸
- Labour force growth: China's labour force has grown moderately compared to real output growth. I rely on data from the National Bureau of Statistics of China that record an average annual growth rate of 1.2 percent since the early 1990s. Bosworth and Collins (2008) report the same annual rate for the period 1993-2004.
- Labour migration: The migration of workers from rural areas to urban centres and from agriculture and subsistence to manufacturing and services is characteristic for China's economic transition and a mayor source of measured income growth. According to data from the National Statistical Office, the share of agriculture in total employment has fallen from 54

⁸ It should be mentioned that the annual TFP growth estimate of 3.9 percent is at the upper end of available numbers. Based on a critical review of official Chinese statistics, other authors have provided more modest estimates. Hu (2010) finds annual TFP growth of only 1.5 percent (1988-2008) on the basis of revised output and factor input data. Young (2003) estimates annual TFP growth of 1.4 percent (1978-98) with strong variation across sectors. Dollar and Wei (2007), and Hsieh and Klenow (2009) find widespread misallocation of production factors across firms and industries. Hsieh and Klenow (2009) estimate that factor reallocation within industries alone could raise Chinese TFP by 30-50 percent.

to 40 percent and the share of manufacturing (services) risen from 23 (23) to 27 (33) percent between 1994 and 2008. I use these numbers that imply an average annual increase in the share of non-agriculture official employment of 1.1 percentage points. Labour reallocation towards industry and services increases the labour supply in the more productive parts of the economy. It also relaxes the liquidity constraints on private households and improves their access to capital markets. The workers that move from informal/subsistence work to manufacturing and service sectors have zero initial wealth. According to the calibration of saving/borrowing constraints in section 5, 70 percent of these migrant households will remain liquidity-constrained, whereas 30 percent obtain access to financial markets and the opportunity to accumulate positive wealth.

- Household savings: Many authors attribute China's net capital exports to the rise in private savings, which is certainly correct. The external surplus reflects an excess of domestic savings over domestic investment. Investment rates have been high and growing in recent years, and the government budget is close to balance or in moderate deficit. Song et al. (2009) attribute the high savings to borrowing constraints that force private firms to finance future investment out of internal savings. Many others (e.g., Blanchard and Giavazzi, 2005; Chamon and Prasad, 2010; Feng et al., 2009; Prasad, 2009b) link the surplus to precautionary saving in the context of poorly developed social security and pension systems. Wei and Zhang (2009) even establish a link between household savings and regional gender imbalances. I include increasing private saving rates as shock to the rate of time preference, i.e. a decline in the preference for the present. The shock is calibrated to replicate the average annual 0.4 percentage-point increase in the private saving rate (1994-2008) reported by the National Bureau of Statistics of China, which is somewhat lower than the annualised 0.6 percentage-point increase (1995-2005) in Chamon and Prasad (2010). In line with the econometric evidence in Horioka and Wan (2007) the saving rate is assumed to remain high in the foreseeable future.

- Export demand growth: China has become increasingly integrated in world trade, amplified by its WTO accession in 2001. Growing world trade has therefore also increased the demand for Chinese exports. I calibrate the path of world trade to the 8 percentage-point increase in the world import-to-GDP share, from 20 percent in 1994 to (estimated) 28 percent in 2010. The calibration implies a comparable increase in the demand for Chinese exports. The growing demand for Chinese exports may be linked to the removal of trade barriers, growing quality and increasing product differentiation.

This set of five shocks is certainly not exhaustive, but it captures important elements of China's economic transition.⁹ Strict exogeneity of the shocks may be challenged, however. FDI inflows and factor reallocation may explain significant parts of aggregate TFP growth. Labour migration is a response to real wage growth and widening regional and sectoral wage differentials. The increase in household saving rates is not only a consequence of exogenous precaution, but also of personal income growth.¹⁰ Treating transition/integration trends as ex-

9 Additional elements include, e.g., investment incentives. The availability of cheap credit from state-owned banks and cheap complementary factors (land, energy) supports investment and capital deepening. The government has also granted significant tax breaks to foreign and joint venture investors to attract FDI and related know-how (Prasad, 2009a; Prasad, 2009b). I do not include simulations for such investment incentives, however, since changes in their net size since the mid-1990s are not obvious, and since constructing a time profile of investment incentives is beyond the reach of this paper.

10 The general finding by Gruber and Kamin (2007) that higher youth and elderly population ratios lower the current account balance supports a role for exogenous savings shocks. Economies with the prospect of population ageing and increasing dependency ratios have an incentive to accumulate wealth and dissave in future periods.

ogenous shocks is a simplification. It may exaggerate or understate actual disturbances, depending on whether the shocks tend to reinforce or offset each other in their impact on measured TFP growth, labour supply and savings. In the future, an estimated model for China would ideally provide a more rigorous distinction between the roles of exogenous shocks and endogenous adjustment.

Simulations start with the "second phase" (McKinnon and Schnabl, 2009) of Chinese exchange rate policy in 1995, with RMB convertibility for current account operations and a RMB-USD peg. Capital controls and the fixed RMB-USD exchange rate are the policy baseline. This policy baseline is also applied to the years since 2005 during which the RMB has gradually revalued vis-à-vis the USD. I extrapolate trends in the exogenous shocks up to 2019 as a hypothetical, but implausible completion of economic transition in 2010 would distort the simulation results for the most recent years.¹¹ The core scenarios assume perfect foresight of the exogenous shocks/trends. The robustness checks include scenarios in which agents update their beliefs about the future path of the exogenous shocks, or in which departures from status quo are continuous surprises.

6.1 Capital controls and Forex intervention

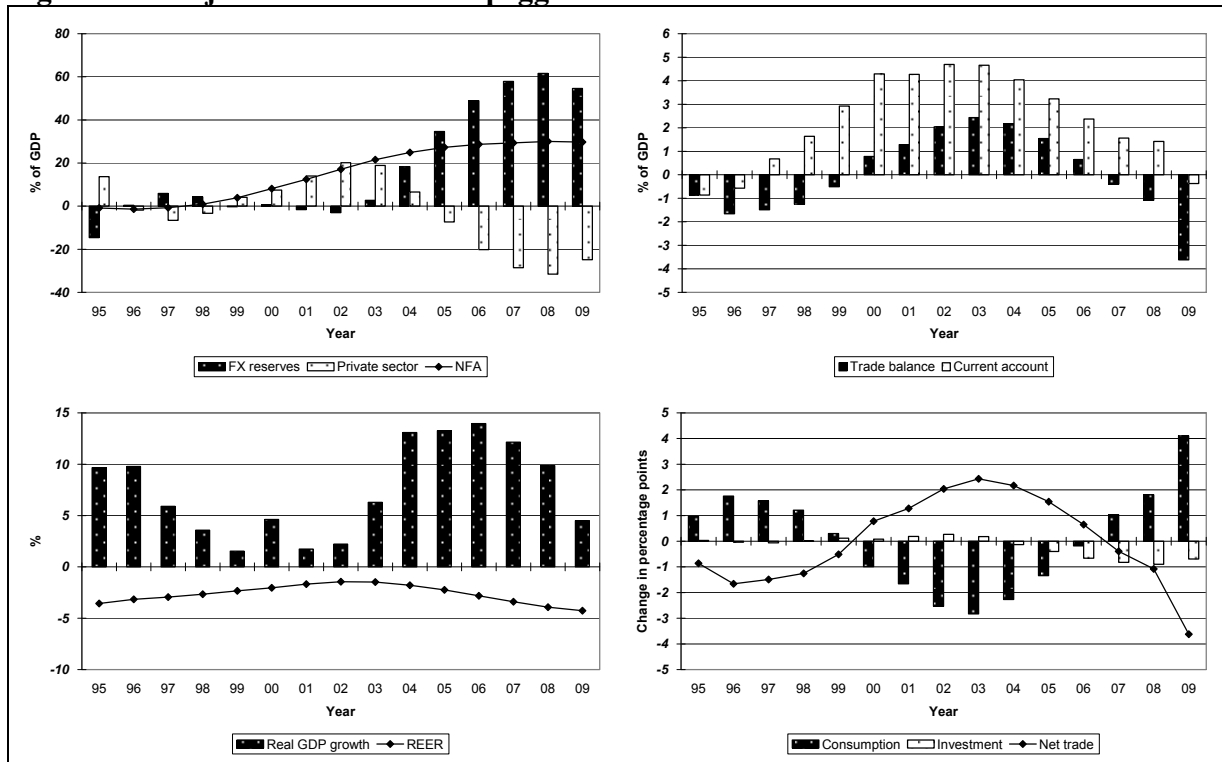
I first look at the policy baseline of limited capital mobility and RMB-USD exchange rate fixation, for which Figure 6.1 shows the joint impact of the five shocks. The figure provides a fairly accurate description of China's NFA accumulation, circa 30 percent of GDP in the simulations and 37 percent of GDP in the data for 2009, and also replicates the coincidence of massive Forex reserves, circa 54 percent of GDP in the simulations and 50 percent of GDP in the data for 2009, with (after some initial increase) negative net non-government sector positions. The REER appreciation implies pressure towards RMB revaluation. To avoid an appreciation of the RMB, the PBC sells RMB and buys USD assets, leading to the accumulation of large Forex reserves at the central bank.

Figure 6.1 also replicates the surplus in the current account and the synchronised movement of the current account and the trade balance. Average annual output growth is lower than reported in the data, but the time paths have similar shape. Contrary to the more monotonous empirical trends (Figure 3.2), the simulations provide alternating changes in the investment-to-output share, the consumption-to-output share and the trade balance.

Separately looking at the shocks illustrates the different impact of the individual components. TFP (Figure 6.2) and labour supply growth (Figure 6.3) increase the return to productive investment and trigger net capital inflows, which manifest in negative current account and trade balances and negative NFA positions. The central bank intervenes to avoid RMB appreciation relative to the USD during the initial phase of real appreciation. The initial Forex reserve accumulation reverts into decumulation as REER appreciation comes to an end. Domestic households become wealthier and the consumption-to-output share increases.¹²

¹¹ Limiting the trend extrapolation to years up to 2014 does not change the qualitative results and only marginally affects the quantitative outcomes of the simulations, however.

¹² Based on anecdotic evidence of a recent slowdown in participation growth, a more modest outlook may expect a decline or stop of labour force growth in the near future instead of the growth trend extrapolation that underlies Figure 6.3. I have rerun the scenario with labour force growth stopping in 2010. Declining labour force growth lowers the expected future return on capital investment and reduces the inflow of capital into China. A slowdown

Figure 6.1: Adjustment with RMB pegged to the USD

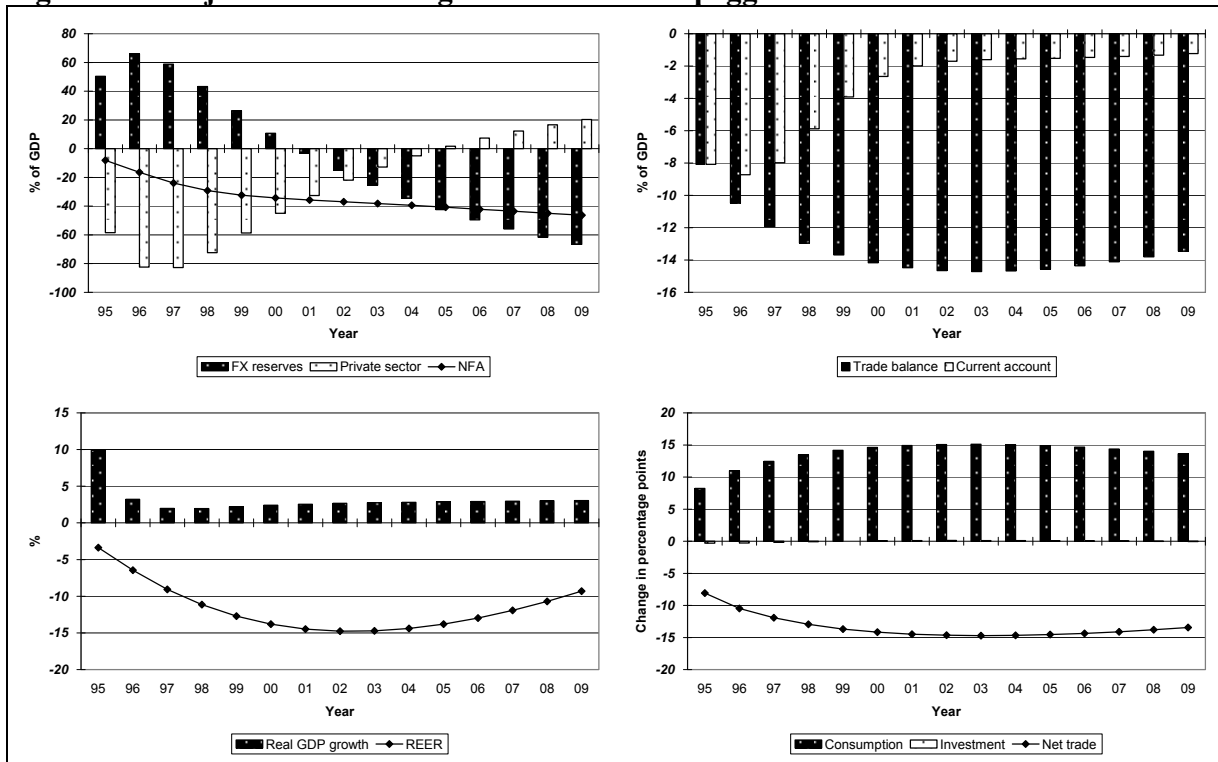
Note: A fall in the REER indicates real effective appreciation.

Labour migration to manufacturing and service sectors (Figures 6.4) and the growth of precautionary saving (Figure 6.5) have opposite effects. The migrant workforce has zero initial assets and starts saving to accumulate positive wealth. Similarly, higher precautionary saving increases private sector net assets positions. External balances improve and the consumption-to-output share declines during the saving growth. Private foreign investment drives overall NFA accumulation, and the growing supply of savings exerts pressure on the RMB to depreciate. The PBC would sell Forex reserves in this situation to avoid RMB devaluation. Only the reversal in the pressure to devalue in later years reverses the pattern to Forex reserve accumulation and declining non-government foreign asset holdings.¹³

of capital inflow moderates pressure towards RMB appreciation and the amount of Forex intervention necessary to stabilise the exchange rate. It also reduces investment growth in China, while the trade balance increases. However, the quantitative impact of the revised growth assumption for labour supply on external balances remains very small; the NFA and current account positions change by less than 0.2% of GDP. The impact on the combined scenario in Figure 6.1 is, by consequence, negligible.

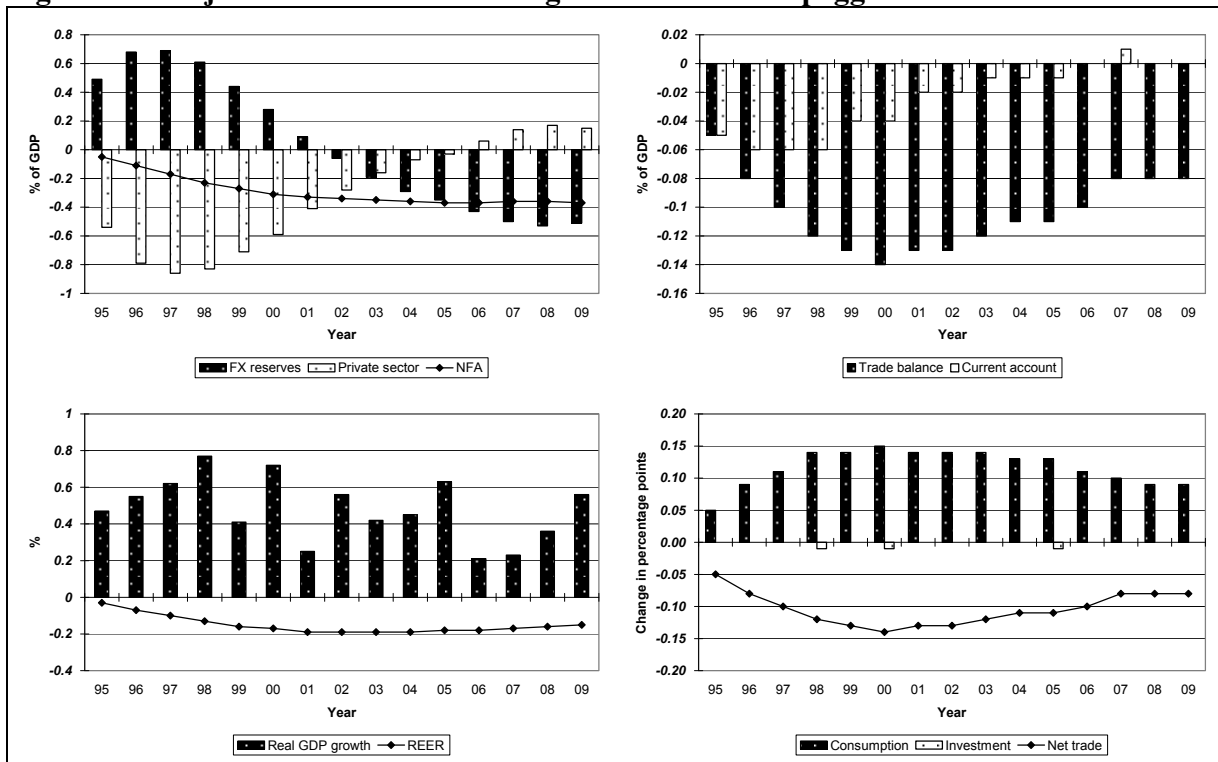
13 Results for the savings shock are compatible with econometric evidence that the current account balance reacts negatively to dependency ratios (Cheung et al., 2010; Chinn and Ito, 2008; Chinn and Prasad, 2003; Ma and Haiwen, 2009), so that economies with lower dependency ratios have on average higher saving rates. Precautionary households save income to accumulate wealth, and they decumulate wealth once their average income declines.

Figure 6.2: Adjustment to TFP growth with RMB pegged to the USD



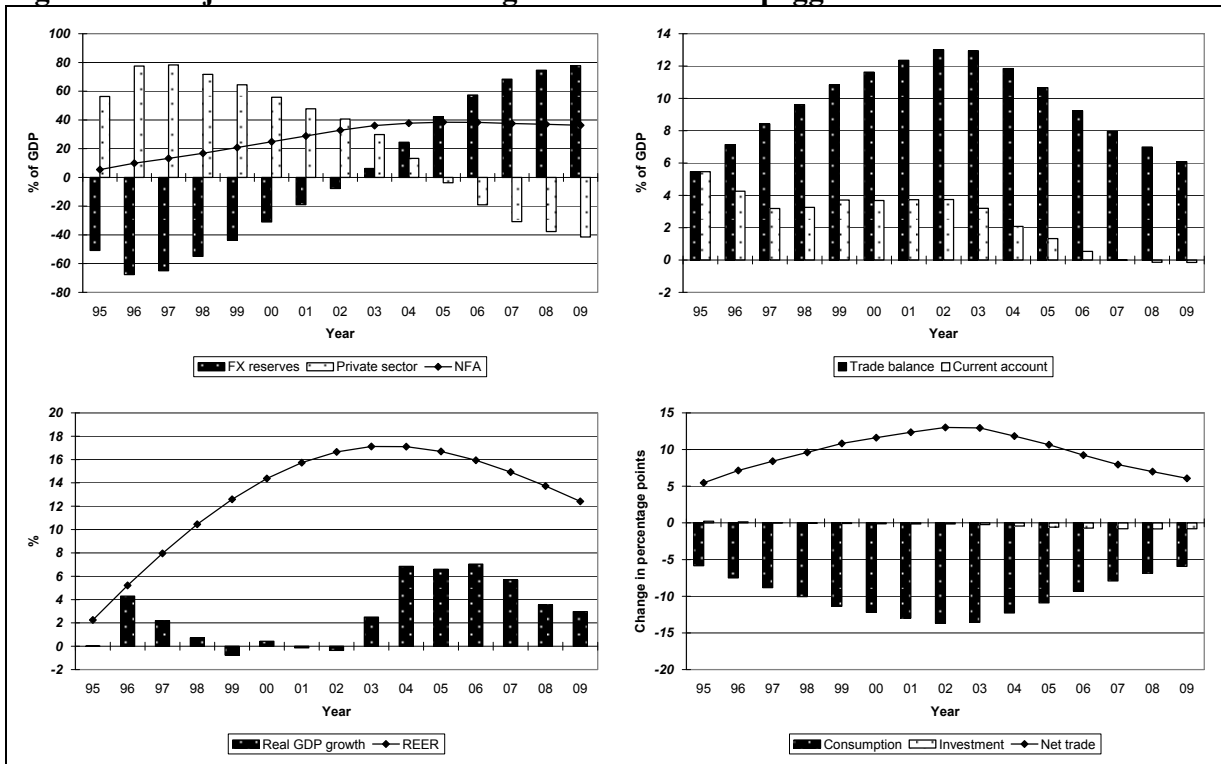
Note: A fall in the REER indicates real effective appreciation.

Figure 6.3: Adjustment to labour force growth with RMB pegged to the USD



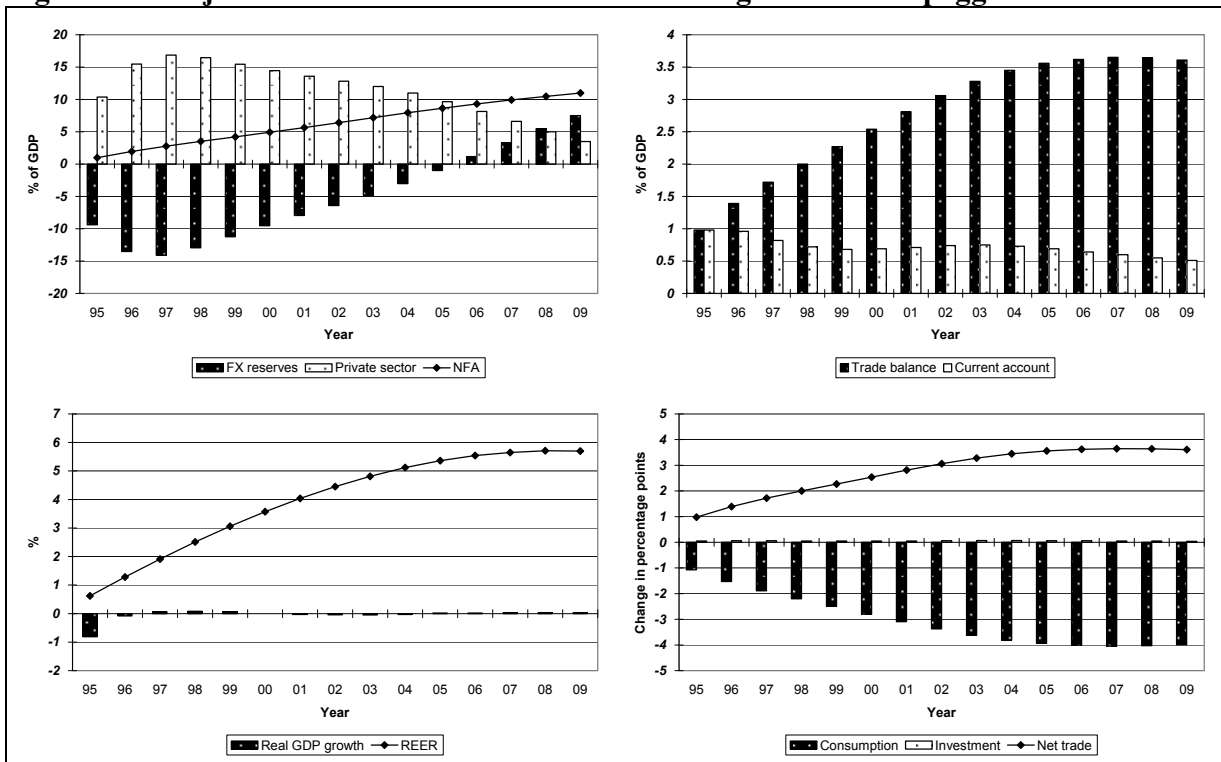
Note: A fall in the REER indicates real effective appreciation.

Figure 6.4: Adjustment to labour migration with RMB pegged to the USD



Note: A fall in the REER indicates real effective appreciation.

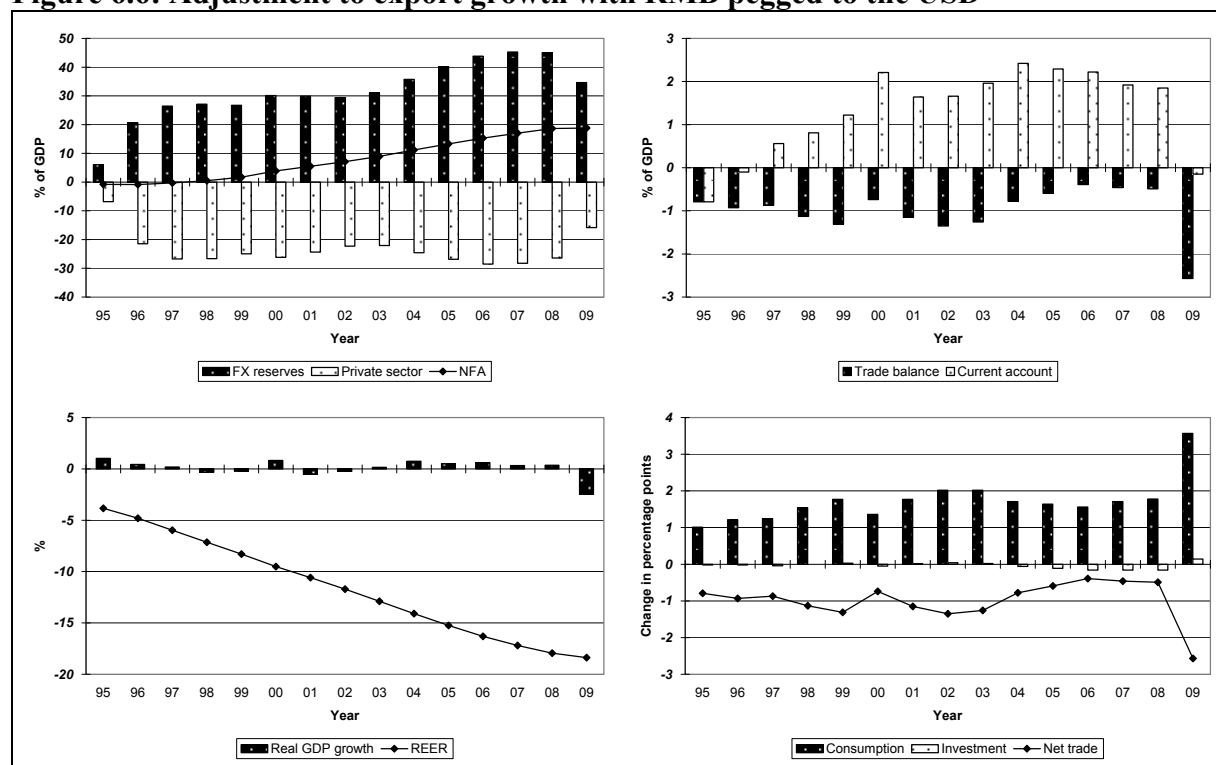
Figure 6.5: Adjustment to increased households savings with RMB pegged to the USD



Note: A fall in the REER indicates real effective appreciation.

The export demand shock (Figure 6.6), finally, comes closest to replicating the NFA pattern individually. Increasing export demand leads to strong REER appreciation. The central bank accumulates massive Forex reserves to maintain the RMB-USD peg. The shock leads to disconnect between the trade balance and the current account, however. Given the increase in the terms of trade and the positive wealth effect from REER appreciation, import growth exceeds export growth and the trade balance deteriorates; thanks to the NFA yield, the current account remains in surplus.

Figure 6.6: Adjustment to export growth with RMB pegged to the USD



Note: A fall in the REER indicates real effective appreciation.

External imbalances are, by definition, equilibrium phenomena in the sense that current account surpluses/deficits require both a supply of and a demand for excess savings. Nevertheless, the imbalances may be driven by either excess savings or excess saving demand. The first scenario is a situation in which global saving demand only follows from a general equilibrium response, without any additional saving demand shock. E.g., excess saving supply reduces world interest rates, which in turn discourages saving and encourages borrowing and investment in other world regions.

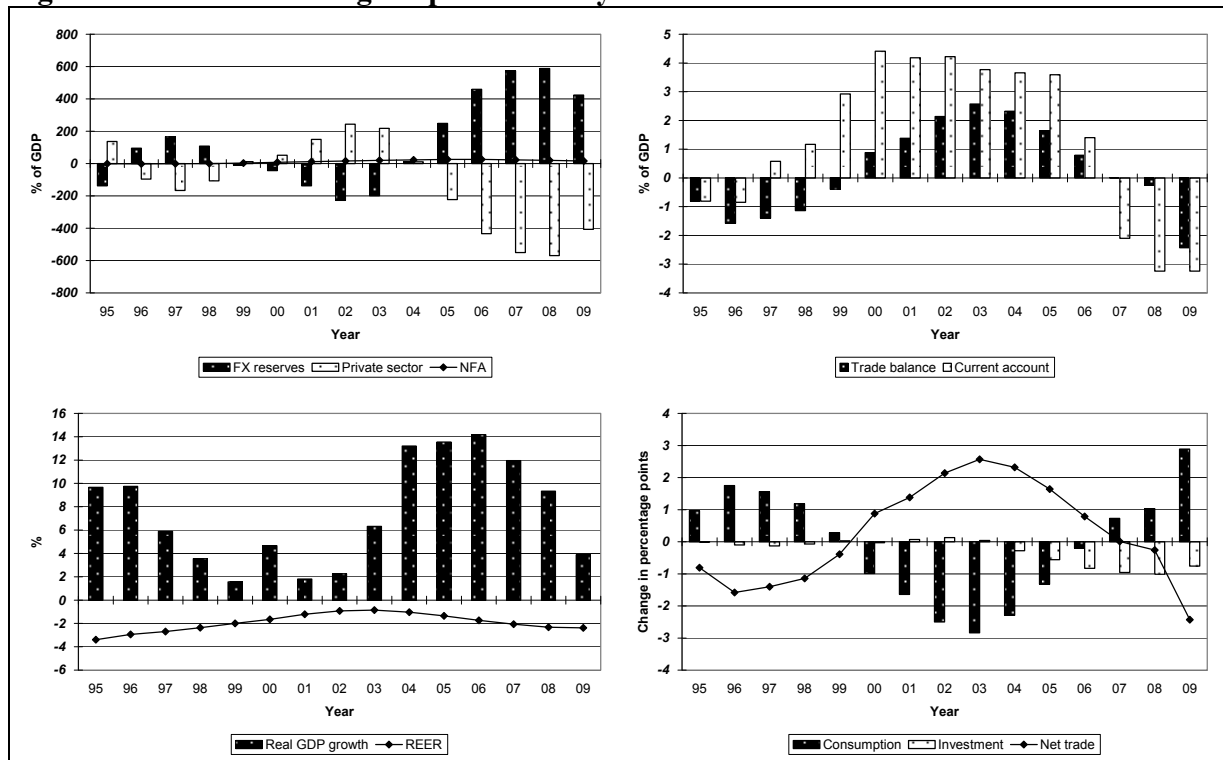
The large positive NFA position in Figure 6.1 suggests that China's external position may indeed be determined by excessive savings in the context of capital controls and RMB-USD fixation. The combination of domestic transition shocks and growing world trade, which does not result from an unsustainable expansion of world demand but from the general increase in openness, replicates the NFA dynamics fairly well, without any asset preference, investment bubble or fiscal profligacy shocks abroad.

6.2 Capital mobility and exchange rate flexibility

I turn now to the contribution of macroeconomic policy to the NFA accumulation, specifically to the impact of capital controls and exchange rate fixation.

Figure 6.7 shows adjustment to the same set of shocks as in Figure 6.1, but with higher capital mobility. The elasticity of cross-border capital flows is increased from $\sigma=0.6$ in the baseline to $\sigma=10$. The higher elasticity implies more extreme asset positions of private and government sectors, whereas the total NFA, the current account and trade balances, and the demand composition remain largely unaffected.¹⁴

Figure 6.7: Model with high capital mobility



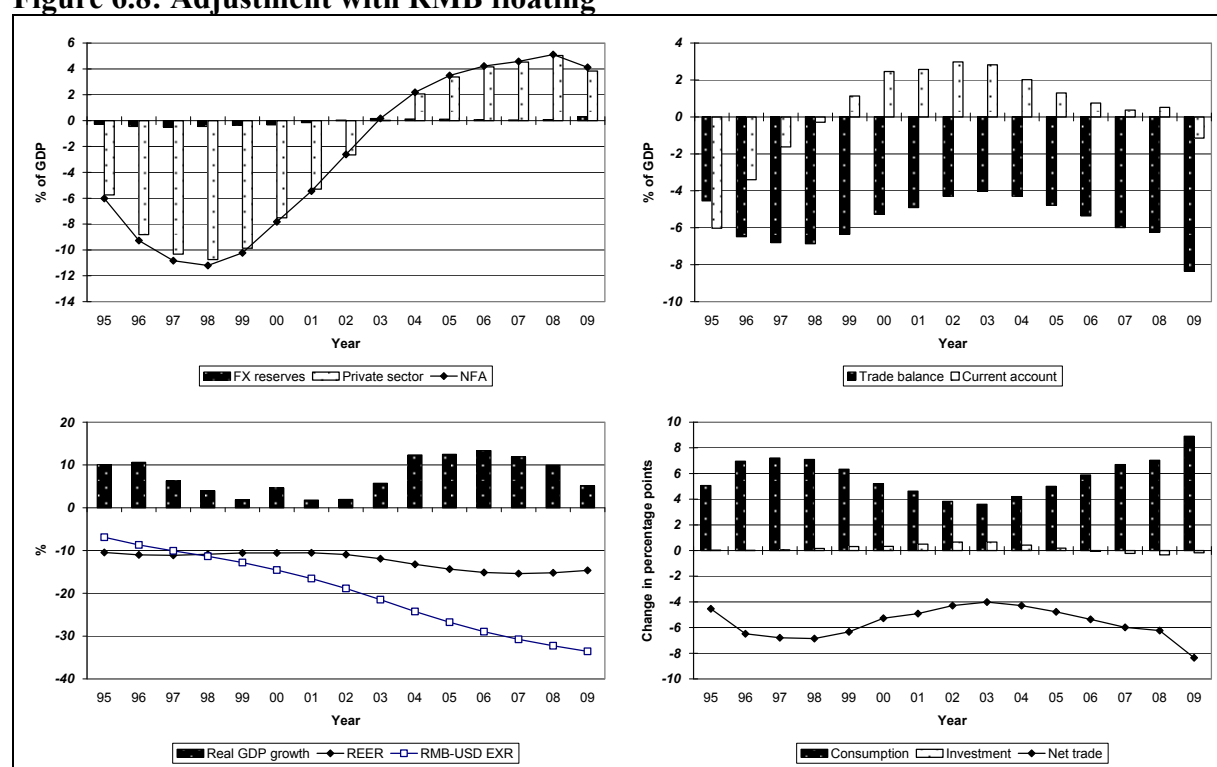
Note: A fall in the REER indicates real effective appreciation.

Comparing the NFA decomposition in Figures 6.1 and 6.7 suggests that relatively low values of σ are appropriate to replicate past developments. It also illustrates the limits of successful Forex intervention. Defending the RMB-USD peg under growing capital mobility requires a massive Forex accumulation that goes far beyond the current and, arguably, beyond viable levels.

¹⁴ The small impact of higher elasticity values on total NFA and current account positions fits to the inconclusiveness of econometric evidence on the issue. Chinn and Ito (2008) find the impact of financial openness on current account balances to be insignificant or, in emerging economies, negative. Chinn and Prasad (2003) find a positive impact of capital controls on the current account balance in industrial countries. Chinn and Wei (2009) find a positive impact of financial openness on current account positions for fixed and floating exchange rates, but not for intermediate regimes of exchange rate management. The impact of the exchange rate regime on external balances, which is insignificant in Chinn and Wei (2009), should depend on the underlying shocks, i.e. on whether exchange rate management prevents or moderates either appreciation or depreciation of the currency.

Figure 6.8 shows adjustment to the same set of shocks under hypothetical RMB floating, keeping capital mobility low at $\sigma=0.6$. The RMB gradually appreciates by circa 30 percent vis-à-vis the USD. The REER appreciation is stronger than under the RMB-USD peg in Figure 6.1. China becomes a net foreign debtor as capital flows into the country to profit from growth in TFP and complementary factor supply and from expected RMB appreciation. The trade balance deteriorates with relative price adjustment and the positive wealth effect from RMB appreciation, but the current account moves into positive territory in the medium term as net interest payments to foreigners decrease with falling domestic interest rates. The size of the NFA positions is much smaller than for adjustment under the currency peg.

Figure 6.8: Adjustment with RMB floating



Note: Falls in the REER and the RMB-USD EXR indicate (real effective) RMB appreciation.

Real output growth in Figure 6.8 is almost identical to the scenario with a RMB-USD peg, but the composition of demand differs markedly. Domestic consumption increases and net exports fall, suggesting that higher exchange rate flexibility is indeed a major policy lever for rebalancing Chinese growth towards domestic demand.

Combining perfect capital mobility and full exchange rate flexibility boils down to the standard QUEST model without portfolio approach, in which the NFA position reflects solely investment decisions of the non-government sector. Standard QUEST results for external balances and growth rebalancing under the set of transition/integration shocks are similar to Figure 6.8. The standard model without portfolio approach only lacks the negative valuation effect on gross asset positions, which results in stronger medium-term NFA positions. After 15 years, the NFA surplus is twice as high as in Figure 6.8.

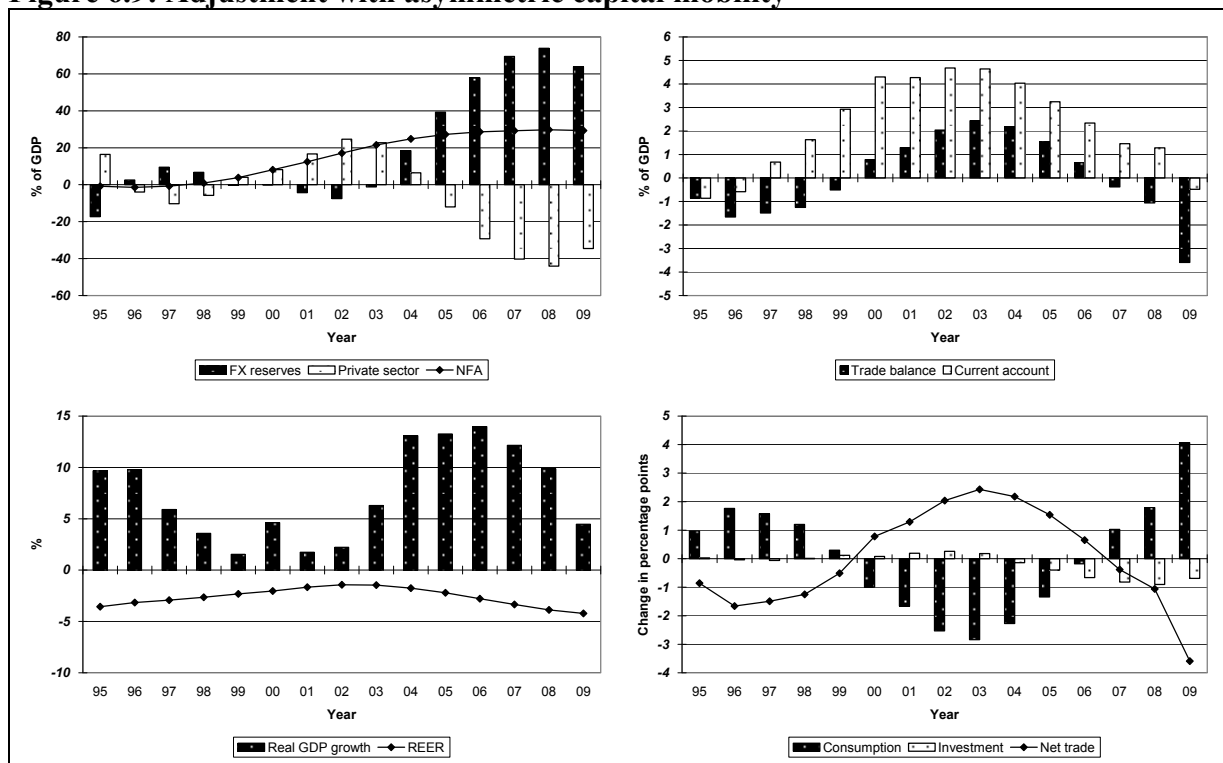
Indeed, Figure 6.8 also highlights the negative valuation effect, i.e. the decline of the value of foreign assets in domestic currency terms in the case of RMB appreciation, as potent political obstacle to RMB flexibility and an argument for gradual approaches.

6.3 Robustness checks

This section delivers robustness checks to test the sensitivity of the simulation results with respect to core assumptions. The checks address three aspects of the calibration, namely the symmetry of capital controls, the relatively low elasticity of labour supply and the perfect-foresight assumption.

Contrary to the baseline calibration, capital controls may be asymmetric. While the Chinese government has encouraged FDI inflows early on, it has been more reluctant to allow domestic firms and household to invest abroad (e.g., Glick and Hutchinson, 2008). Figure 6.9 shows that asymmetry in the cross-border mobility of capital does not alter the aggregate dynamics. Exchange rate fixation with lower outward ($\sigma^d=0.3$) and higher inward ($\sigma^f=0.9$) capital mobility generates almost identical adjustment, only with somewhat stronger Forex reserve accumulation at the central bank and somewhat higher net foreign debt in the private sector.

Figure 6.9: Adjustment with asymmetric capital mobility



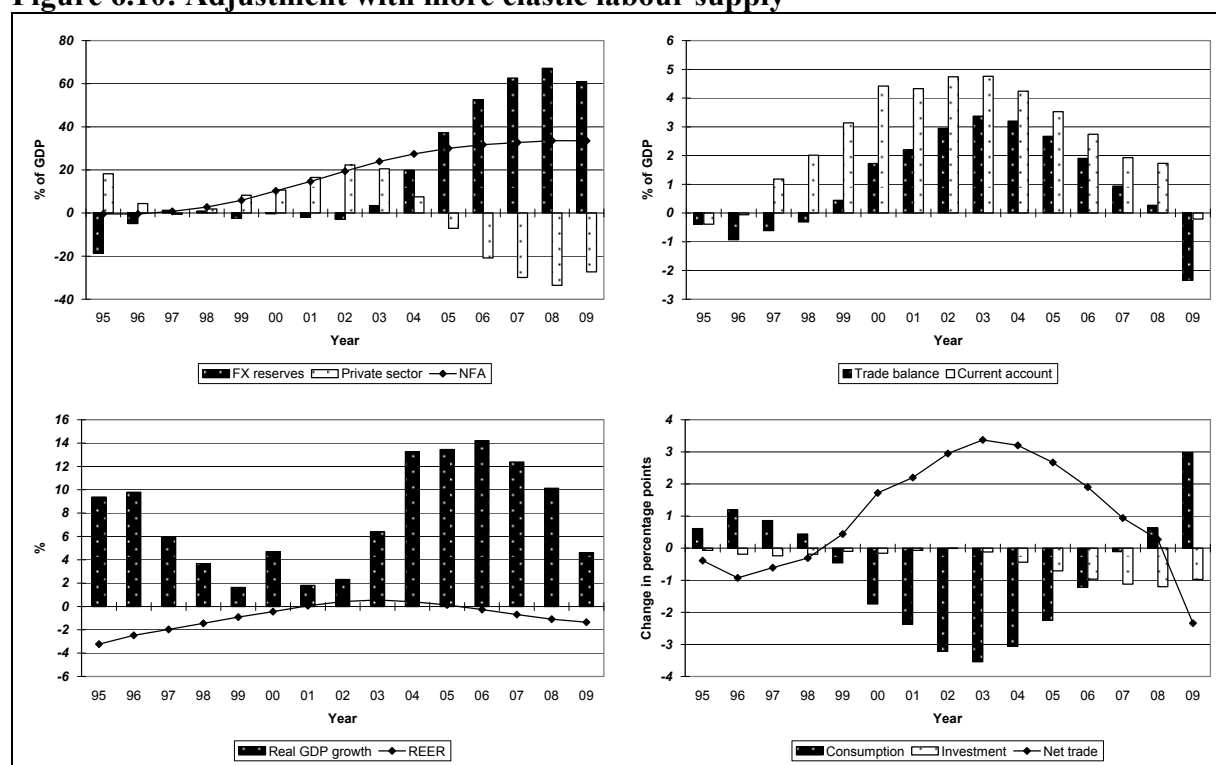
Note: A fall in the REER indicates real effective appreciation.

There is a widespread prior that Chinese households display a high elasticity of labour supply, coming close to the Lewis model with unlimited labour supply at fixed wages (Fields, 2004; Lewis, 1954). Despite this prior, Fleisher and Wand (2004) estimate a rather low elasticity of labour supply with respect to wages of around 1/5. The fact that post-1994 wage growth in Chinese manufacturing has followed the growth in labour productivity (McKinnon, 2006),

which corresponds to the simulation results, does also not support the idea of infinite labour supply at given wages in the official economy.

Nevertheless, Figure 6.10 shows simulation outcomes for more elastic labour supply. I increase the elasticity from $1/5$ to $1/3$, which is the value used for the US economy. The simulation results for external stock and flow balances, output growth and demand composition are practically identical to Figure 6.1 with the baseline calibration.

Figure 6.10: Adjustment with more elastic labour supply

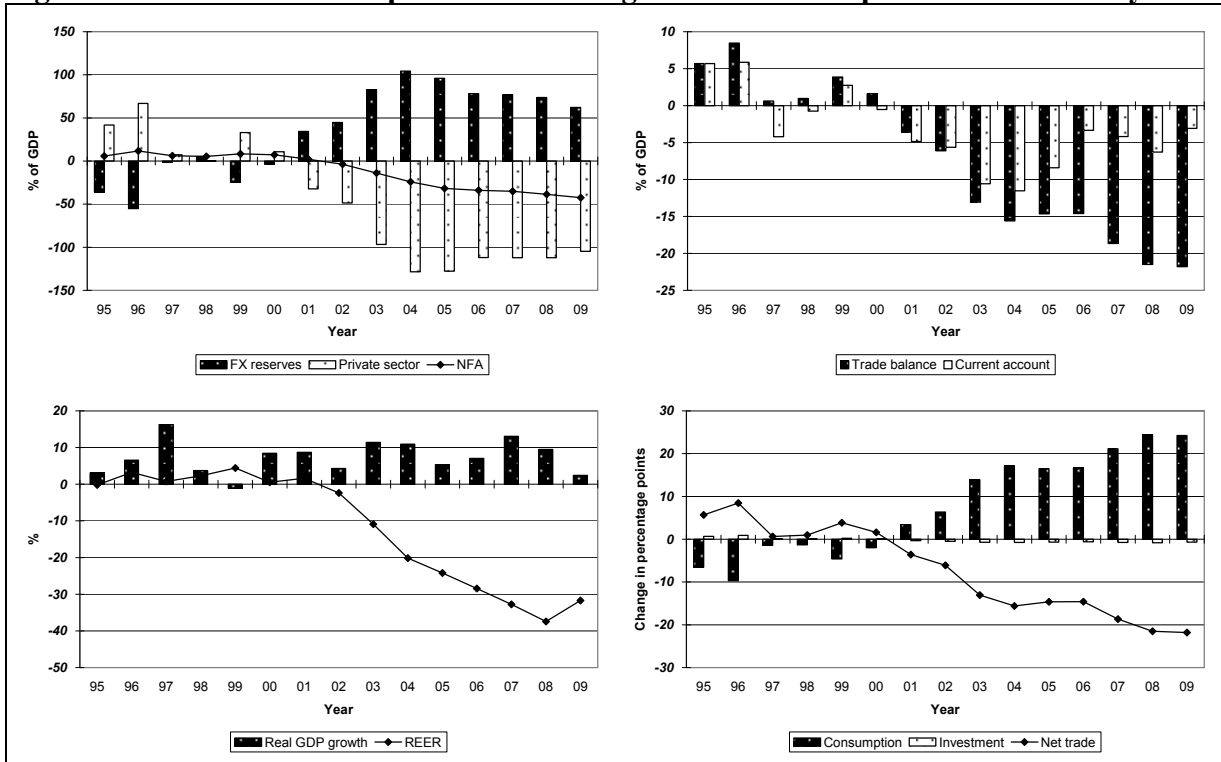


Note: A fall in the REER indicates real effective appreciation.

The final variants replace the assumption of perfect foresight with regard to the exogenous shocks that underlies the previous simulations. An intermediate scenario combines some forecasting of future changes with a regular updating of beliefs. The extreme alternative assumes that all changes in the exogenous variables in each period come as surprises and that agents expect the exogenous variables to remain at their status quo levels thereafter.

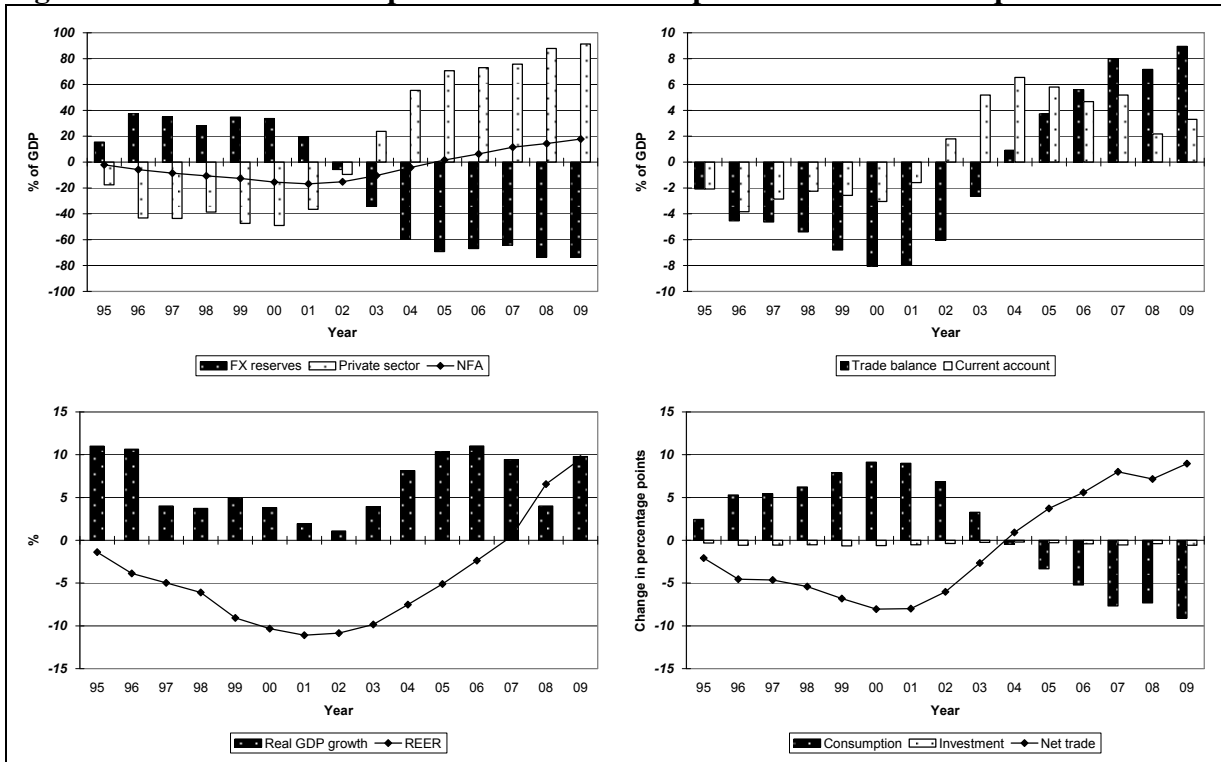
Figure 6.11 presents the intermediate scenario. At each period of time, agents do not know ex ante the actual size of the shocks. But, although the actual shocks are surprises, agents forecast the future path of the exogenous variables. Specifically, I assume that agents extrapolate the recent change over the subsequent three years and, in the absence of reliable long-term information, assume the exogenous variables to remain constant thereafter.

Figure 6.11: Model with surprise shocks and growth rate extrapolation over three years



Note: A fall in the REER indicates real effective appreciation.

Figure 6.12: Model with surprise shocks and extrapolation of the status quo



Note: A fall in the real REER indicates real effective appreciation.

Backward-looking expectation formation has considerable impact on the adjustment dynamics. It generates higher net creditor and debtor positions of government and non-government sectors compared to Figure 6.1. The central bank intervenes to prevent RMB appreciation, but the NFA turns negative in the medium term. Domestic interest rates start rising sharply after six years as inflation rises, implying large net interest payments to the rest of the world that deteriorate the external balances.

The simple extrapolation of status quo levels after surprise shocks in each period (Figure 6.12) generates a net creditor position of the private sector together with a decumulation of Forex reserves by the central bank. In the absence of positive expectations about future TFP and factor supply growth that would enhance the profitability of domestic investment, households export their savings. Equally, capital inflows to the country are more modest than with higher expected profitability. Contrary to the benchmark scenario of Figure 6.1, the central bank intervenes to avoid depreciation, instead of appreciation, of the RMB.

Taken together, Figures 6.11 and 6.12 show that the nature of exogenous shocks/expectations (foresight versus extrapolation) influences significantly the simulation results. At the same time, it seems plausible to assume that households and firms have rather realistic expectations about the long-term trends of economic transition and globalisation.

7. CONCLUSIONS

The paper uses a multi-region DSGE model of the world economy (China, US, euro area, RoW) to look at China's particular role as rapidly growing emerging economy and large international creditor.

The model features two key elements of Chinese macroeconomic policy, namely a portfolio approach that distinguishes gross/net and private/public foreign asset positions and includes limited capital mobility as modelling device for cross-border capital controls, and exchange rate management in the form of sterilised Forex intervention. The rest of model is fairly standard in that it includes only distortions/frictions in the China block that are standard also in the euro area and US settings.

The paper selects a set of shocks that covers important aspects of China's economic transition and integration in the world economy, namely TFP catch-up, labour supply growth, labour reallocation, precautionary saving and export growth, and investigates its ability to match key stylised facts, namely the NFA accumulation that combines increasing Forex positions of the central bank with a debtor position of the non-government sector, persistent surpluses in the trade balance and the current account, high real output growth, and declining (increasing) domestic demand shares of consumption (investment).

The simulations show that the set of shocks replicates China's external position quite well in the benchmark setting with limited capital mobility and Forex intervention, though the fit is less satisfactory for domestic demand shares. The fact that the set of domestic and trade shocks replicates the large NFA and Forex positions supports the hypothesis that China's surplus represents shifts in domestic saving supply, rather than exogenous shifts in foreign saving demand.

The simulations also highlight the importance of effective capital controls, i.e. binding restrictions on cross-border capital flows, for the viability of China's exchange rate management. Increasing cross-border capital mobility, i.e. financial liberalisation, would require the central bank to accumulate Forex reserves well beyond current and, arguably, beyond viable levels.

Finally, the analysis suggests that greater flexibility of the RMB exchange rate could reduce China's net creditor position and contribute to a change in China's growth composition from exports to domestic demand.

Robustness checks indicate that neither the potential asymmetry of capital controls nor alternative values for the elasticity of labour supply affect the results in significant ways. Assumptions on expectation formation (perfect foresight versus simple extrapolation) appear crucial, however. Specifically, the good performance of the model in replicating China's external position is conditional on the assumption that agents have fairly accurate expectations about the long-term nature of the transition and globalisation trends.

The analysis leaves ample space for improvement, refinement and further research. Additional work on the empirical validation of the model structure, the parameter and the shock calibration would certainly increase the analytical value of the results. Future studies would ideally be based on a coherently estimated model of the Chinese economy.

REFERENCES

- Ahmed, S. (2009): "Are Chinese Exports Sensitive to Changes in the Exchange Rate?" Board of Governors of the Federal Reserve System International Finance Discussion Paper 987.
- Bayoumi, T., H. Tong and S. Wei (2010): "The Chinese Corporate Savings Puzzle: A Firm-Level Cross-Country Perspective," NBER Working Paper 16432.
- Bems, R., L. Dedola and F. Smets (2007): "US Imbalances: The Role of Technology and Policy," *Journal of International Money and Finance* 26, 523-545.
- Blanchard, O. (2007): "Current Account Deficits in Rich Countries," IMF Staff Paper 54, 191-219.
- Blanchard, O. and F. Giavazzi (2005): "Rebalancing Growth in China: A Three-Handed Approach," CEPR Discussion Paper 5403.
- Blanchard, O., F. Giavazzi and F. Sa (2005): "International Investors, the US Current Account, and the Dollar," *Brookings Papers on Economic Activity* 1, 1-49.
- Bosworth, B. and S. Collins (2008): "Accounting for Growth: Comparing China and India," *Journal of Economic Perspectives* 22, 45-66.
- Bracke, Th. and M. Fidora (2008): "Global Liquidity Glut or Global Savings Glut?" ECB Working Paper 911.
- Breuss, F., W. Roeger and J. in't Veld (2009): "Global Impact of a Shift in Foreign Reserves to Euros," *Empirica* 36, 101-122.
- Bussière, M., M. Fratzscher and G. Mueller (2005): "Productivity Shocks, Budget Deficits and the Current Account," ECB Working Paper 509.
- Caballero, R., E. Farhi and P. Gourinchas (2008): "An Equilibrium Model of Global Imbalances and Low Interest Rates," *American Economic Review* 98, 358-393.
- Chamon, M. and E. Prasad (2010): "Why Are Saving Rates of Urban Households in China Rising?" *American Economic Journal: Macroeconomics* 2, 93-130.
- Cheung, C., D. Furceri and E. Rusticelli (2010): "Structural and Cyclical Factors behind Current-Account Balances," OECD Economics Department Working Paper 775.
- Cheung, Y.-W., M. Chinn and E. Fujii (2007a): "The Fog Encircling the Renminbi Debate," *Singapore Economic Review* 52, 403-418.
- Cheung, Y.-W., M. Chinn and E. Fujii (2007b): "The Overvaluation of Renminbi Undervaluation," *Journal of International Money and Finance* 26, 762-785.
- Cheung, Y.-W., D. Tam and M. Yiu (2008): "Does the Chinese Interest Rate Follow the US Interest Rate?" *International Journal of Finance and Economics* 13, 53-67.

Cheung, Y.-W., M. Chinn and E. Fujii (2009): "China's Current Account and Exchange Rate," NBER Working Paper 14673.

Chinn, M. and E. Prasad (2003): "Medium-Term Determinants of Current Accounts in Industrial and Developing Countries: An Empirical Exploration," *Journal of International Economics* 59, 47-76.

Chinn, M. and H. Ito (2008): "Global Current Account Imbalances: American Fiscal Policy versus East Asian Savings," *Review of International Economics* 16, 479-498.

Chinn, M. and S. Wei (2009): "A Faith-Based Initiative: Do We Really Know that a Flexible Exchange Rate Regime Facilitates Current Account Adjustment?" NBER Working Paper 14420.

Choi, H. and N. Mark (2009): "Trending Current Accounts," NBER Working Paper 15244.

Choi, H., N. Mark and D. Sul (2008): "Endogenous Discounting, the World Saving Glut and the U.S. Current Account," *Journal of International Economics* 75, 30-53.

Cline, W. and J. Williamson (2009): "New Estimates of Fundamental Equilibrium Exchange Rates," Peterson Institute for International Economics Policy Brief 09-10.

Corsetti, G. and G. Mueller (2006): "Twin Deficits: Squaring Theory, Evidence and Common Sense," *Economic Policy* 21, 597-638.

Cova, P., M. Pisani and A. Rebucci (2009): "Global Imbalances: The Role of Emerging Asia," *Review of International Economics* 17, 716-733.

Dollar, D. and A. Kraay (2006): "Neither a Borrower nor a Lender: Does China's Zero Net Foreign Asset Position Make Economic Sense?" *Journal of Monetary Economics* 53, 943-971.

Dollar, D. and S. Wei (2007): "Das (Wasted) Kapital: Firm Ownership and Investment Efficiency in China," IMF Working Paper 07/09.

Dooley, M., D. Folkerts-Landau and P. Garber (2007): "Direct Investment, Rising Real Wages and the Absorption of Excess Labor in the Periphery," in: R. Clarida (ed.): *G-7 Current Account Imbalances: Sustainability and Adjustment*, Chicago University Press, Chicago, 103-130.

Faruqee, H., D. Laxton, D. Muir and P. Pesenti (2007): "Smooth Landing or Crash? Model-Based Scenarios of Global Current Account Rebalancing," in: R. Clarida (ed.): *G-7 Current Account Imbalances: Sustainability and Adjustment*, Chicago University Press, Chicago, 377-455.

Feng, J., L. He and H. Sato (2009): "Public Pensions and Household Saving: Evidence from China," Bank of Finland BOFIT Discussion Paper 2/2009.

Fields, G. (2004): "Dualism in the Labour Market: A Perspective on the Lewis Model after Half a Century," *The Manchester School* 72, 724-735.

Fleisher, B. and X. Wang (2004): "Skill Differentials, Return to Schooling, and Market Segmentation in a Transition Economy: The Case of Mainland China," *Journal of Development Economics* 73, 315-328.

Gertler, M. (1999): "Government Debt and Social Security in a Life-Cycle Economy," *Carnegie-Rochester Conference Series on Public Policy* 50, 61-110.

Glick, R. and M. Hutchinson (2008): "Navigating the Trilemma: Capital Flows and Monetary Policy in China," *Federal Reserve Bank of San Francisco Working Paper* 2008-32.

Gruber, J. and S. Kamin (2007): "Explaining the Global Pattern of Current Account Imbalances," *Journal of International Money and Finance* 26, 500-522.

Herd, R., V. Koen and A. Reutersward (2010): "China's Labour Market in Transition: Job Creation, Migration and Regulation," *OECD Economic Department Working Paper* 749.

Horioka, Ch. and J. Wan (2007): "The Determinants of Household Saving in China: A Dynamic Panel Analysis of Provincial Data," *Journal of Money, Credit and Banking* 39, 2077-2096.

Hsieh, Ch. and P. Klenow (2009): "Misallocation and Manufacturing TFP in China and India," *Quarterly Journal of Economics* 124, 1403-1448.

Hu, H. (2010): "Accounting for China's Growth in 1952-2008," Paper presented at the 2010 AEA Meeting, January 2-5, 2010, Atlanta.

Korhonen, I. and M. Ritola (2009): "Renminbi Misaligned - Results from Meta Regressions," *Bank of Finland BOFIT Discussion Paper* 13/2009.

Koivu, T., A. Mehrotra and R. Nuutilainen (2008): "McCallum Rule and Chinese Monetary Policy," *Bank of Finland BOFIT Discussion Paper* 15/2008.

Lane, Ph. and G. Milesi-Ferretti (2007): "The External Wealth of Nations Mark II," *Journal of International Economics* 73, 223-250.

Lee, J. and W. McKibbin (2006): "Domestic Investment and External Imbalances in East Asia," *Brookings Discussion Papers in International Economics* 172.

Lewis, A. (1954): "Economic Development with Unlimited Supply of Labour," *The Manchester School* 22, 139-191.

Li, K. (2009): "China's Total Factor Productivity Estimates by Region, Investment Sources and Ownership," *Economic Systems* 33, 213-230.

Liu, L. and W. Zhang (2007): "A New Keynesian Model for Analysing Monetary Policy in Mainland China," *Hong Kong Monetary Authority Working Paper* 18/2007.

Ma, G. and R. McCauley (2008): "Efficacy of China's Capital Controls: Evidence from Price and Flow Data," *Pacific Economic Review* 13, 104-123.

- Ma, G. and Z. Haiwen (2009): "China's Evolving External Wealth and Rising Credit Position," BIS Working Paper 286.
- McKinnon, R. (2006): "China's Exchange Rate Trap: Japan Redux?" *American Economic Review* 96, 427-431.
- McKinnon, R. (2007): "Why China Should Keep its Dollar Peg," *International Finance* 10, 43-70.
- McKinnon, R. and G. Schnabl (2009): "The Case for Stabilizing China's Exchange Rate: Setting the Stage for Fiscal Expansion," *China & World Economy* 17, 1-32.
- Mendoza, E., V. Quadrini and J. Rios-Rull (2007): "Financial Integration, Financial Deepness and Global Imbalances," NBER Working Paper 12909.
- Mehrotra, A., T. Peltonen and A. Santos Rivera (2007): "Modelling Inflation in China - A Regional Perspective," Bank of Finland BOFIT Discussion Paper 19/2007.
- Modigliani, F. and S. Cao (2004): "The Chinese Savings Puzzle and the Life-Cycle Hypothesis," *Quarterly Journal of Economics* 42, 145-170.
- N'Diaye, P., P. Zhang and W. Zhang (2010): "Structural Reform, Intra-Regional Trade, and Medium-Term Growth Prospects of East Asia and the Pacific - Perspectives from a New Multi-Region Model," *Journal of Asian Economics* 21, 20-36.
- Obstfeld, M. and K. Rogoff (1996): *Foundations of International Macroeconomics*, MIT Press, Cambridge, Mass.
- Ouyang, A., R. Rajan and T. Willett (2008): "Managing the Monetary Consequences of Reserve Accumulation in Emerging Asia," *Global Economic Review* 37, 171-199.
- Prasad, E. (2009a): "Is the Chinese Growth Miracle Built to Last?" *China Economic Review* 20, 103-123.
- Prasad, E. (2009b): "Rebalancing Growth in Asia," NBER Working Paper 15169.
- Prasad, E. and R. Rajan (2008): "A Pragmatic Approach to Capital Account Liberalization," *Journal of Economic Perspectives* 22, 149-172.
- Ratto, M., W. Roeger and J. in't Veld (2009): "QUEST III: An Estimated DSGE Model of the Euro Area with Fiscal and Monetary Policy," *Economic Modelling* 26, 222-233.
- Ratto, M., W. Roeger and J. in't Veld (2010): "Using a DSGE Model to Look at the Recent Boom-Bust Cycle in the US," *European Economy Economic Paper* 397.
- Roeger, W. (2003): "Explaining Long Term International Capital Flows," mimeo.
- Song, Z., K. Storesletten and F. Zilibotti (2009): "Growing Like China," CEPR Discussion Paper 7149.

Straub, R. and Ch. Thimann (2009): "The External and Domestic Side of Macroeconomic Adjustment in China," ECB Working Paper 1040.

Wei, S. and X. Zhang (2009): "The Competitive Saving Motive: Evidence from Rising Sex Ratios and Savings Rates in China," NBER Working Paper 15093.

Wen, Y. (2009): "Saving and Growth under Borrowing Constraints: Explaining the High Savings Rate Puzzle," Federal Reserve Bank of St. Louis Working Paper 2009-045B.

Woelfl, A., I. Wanner, T. Kozluk and G. Nicoletti (2009): "Ten Years of Product Market Reform in OECD Countries: Insights from a Revised PMR Indicator," OECD Economic Department Working Paper 695.

Xiao, G. (2008): "China's Exchange Rate and Monetary Policies: Structural and Institutional Constraints and Reform Options," Asian Economic Papers 7, 31-49.

Young, A. (2003): "Gold into Base Metals: Productivity Growth in the People's Republic of China during the Reform Period," Journal of Political Economy 111, 1220-1261.

Yu, Y. (2007): "Global Imbalances and China," Australian Economic Review 40, 3-23.

Zhang, Y. and G. Wan (2004): "Liquidity Constraint, Uncertainty and Household Consumption in China," Applied Economics 36, 2221-2229.